EDITED BY HARRY VAN DER HULST

Word Stress

Theoretical and Typological Issues

CAMBRIDGE

Word Stress

Word stress has long presented challenges to phonologists, as they have sought to uncover patterns in its distribution, and to devise models to account for its behavior and formal representation, both within single languages and cross-linguistically. In this collection, a team of world-renowned researchers present a variety of viewpoints on the methods and problems involved. Offering fresh perspectives on the topic and its study, this book is specifically concerned with basing theoretical work on broad typological surveys and focuses on the collection, selection, and use of data in the analysis of word stress and word rhythm, including their phonetic manifestations. An extensive introduction presents a state-of-the-art review of stress research. The contributors also present StressTyp2, a project in an advanced stage of development, which intends to make information on word stress in a broad sample of languages publicly available, and will offer new ways of understanding this key research area.

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Preface

This volume contains 10 chapters that all originated from presentations at the First or Second Word Accent Conference held at the University of Connecticut on April 30, 2010 and December 3, 2011, respectively. The speakers that were invited for these events shared an approach, characteristic of this domain of study, which aims at the formation of theories (of word stress) that are based on broad typological and phonetic research. To enhance their intentions for future collaboration they all agreed to contribute a chapter to the present volume. These chapters in the form in which they appear here are not brief conference-style presentations, but solid contributions which have been updated, anonymously reviewed, and fully written for this volume. An additional introductory chapter provides an overview of stress theories and research, as well as a summary of the chapters in this book.

Part I

The phenomenon of stress

1 The study of word accent and stress: past, present, and future

Harry van der Hulst

1.1 Introduction

This volume contains ten chapters that all originated from presentations at the First or Second Word Accent Conference held at the University of Connecticut on April 30, 2010 and December 3, 2011, respectively. The first conference brought together phonologists who share an interest in the study of word stress, based on broad typological surveys.[1] In several cases, such surveys have taken the form of digital databases which contain information about stress properties of large numbers of languages. In particular, two such databases (*StressTyp* and *Stress Pattern Database*) are publicly available on the WWW.[2] While the chapters in this volume are based on public talks, the ('hidden') goal of the first conference was to develop a grant proposal which would allow the architects of these databases to merge the two resources into one system, to be named *StressTyp2*.[3] Beyond merger, the goal was to enrich the information, both in terms of depth (detail of encoding) and breadth (number of languages) and to improve quality and accessibility of the data. Like the first conference, the second conference (which occurred after the grant had been obtained) had a part with public lectures and a 'closed door session' which aimed at discussing the design of a new relational database structure and desiderata for a user-friendly front end for StressTyp2. The chapters in the present volume are *not* concerned with the technical details of the StressTyp2 project, but are based on some of the public talks in which more general issues were addressed, relating to typologically based theoretical work.[4] In general terms, these chapters, taken as a whole, reflect on issues concerning the nature of word stress and the

[1] This conference was made possible by a Large Faculty Grant of the University of Connecticut awarded to Harry van der Hulst.

[2] See section 1.9 for a discussion of these projects.

[3] This effort led to NSF grants NSF#1123661 (PI Harry van der Hulst) and NSF# 1123692 (PI Jeffrey Heinz), which allowed us to plan and execute the merger and currently supports ongoing work on StressTyp2, which is accessible at http://st2.ullet.net.

[4] All chapters are the result of a blind double peer-review process and were last updated in September 2012.

methodology of studying the relevant phenomena, as well as the actual and potential applications of typological data collections in any form, either with reference to theoretical issues or to language contact situations.

In this introductory chapter,[5] my goal is to situate the chapters within the broader context of the study of word stress. I survey relevant areas of research, raise questions, and point to topics that require closer attention. To this end, section 1.2 first discusses some terminological matters. This section is followed by several sections (1.3–1.7) which go over more theoretical issues regarding the distinction between the lexical specification and phonetic exponents of stress, distinctions between levels or kinds of stress, and the role of morphology and of intonation. Section 1.8 reviews some special themes in past and current theoretical work on stress, including the area of learnability and acquisition. Section 1.9 provides factual information about the above-mentioned database projects. In section 1.10, I summarize the chapters in this volume, point out their relevance to the issues that are addressed in this 'Introduction', and highlight some of the ways in which these studies are interconnected. In section 1.11, I conclude with perspectives for future research in this area.

1.2 Terminological issues

In this section I discuss a number of terminological points. While these cannot always be separated from theoretical issues or substantive issues, i.e. distinctions that are 'sensible' to make, even independent of any specific theory, I will try to not get into theoretical issues until section 1.3, realizing that the separation between terminology, substance, and theory is intrinsically unclear, if not unprincipled. Where relevant, I will make references to the chapters in this volume, with a more complete assessment of these being the subject of section 1.10.

This section focuses on the well-known issue that the use of the terms 'stress' and 'accent' is somewhat problematic. This may easily lead to confusion when comparing different traditions or theories. In one respect, the two terms can be understood as being *translations* of each other (as in *stress* being an English term and *accent* a French term for the same thing, whatever that thing is). However, given the widespread use of Romance vocabulary in many Germanic languages and the widespread use of English terms in many more languages, we often end up with *both* terms, either as synonyms or as having acquired their own specialized meanings. Putting aside the translation and synonym instances, let us focus on how the two terms, when used within the same

[5] I would like to thank all contributors to this volume for their comments on earlier versions of this chapter. In addition, I'm grateful for comments from Anthi Revithiadou and Beata Moskal.

language (or theory of language), have come to differ. As Fox (2000: 114), in his highly informative book on prosody, notes: "The term *accent* is used in a number of legitimate ways by different scholars, and many of these uses are mutually incompatible." The same can be said for the term *stress*. If used in contrast with the term 'stress', perhaps the biggest confusion is that 'accent' can be something that lies 'below' stress (being 'more abstract' than stress) as well as something that occurs 'above' or 'later than' stress (being associated to the realization of stress, in particular in relation to intonational properties):

(1)

Accent (Intonation, i.e. 'pitch-accent')

↑

Stress

↑

Accent (lexicon)

In (1) I indicate that the 'abstract use' of the term 'accent' (as *underlying* stress) refers to a lexical property of lexemes (morphemes or words) which marks the *location* of certain types of observable stress properties that occur in words; often, then, the term 'stress' is simply used as a cover term for these observable phonetic properties (such as greater duration, greater intensity, etc.). The following quote from Abercrombie (1976 [1991: 82–3]) is a good description of this use of the term 'accent':

> When I say that such-and-such syllable of a word has an (or the) accent, or is accented (other syllables therefore being unaccented), I am not saying anything about the phonetic characteristics of that syllable. All that is being said is that in certain conditions (which must be specified) in utterances, an accented syllable will show certain characteristics which can be predicted. The various possible realisations of accent may have nothing phonetic in common. An accented syllable *may* be realised as stress, with various features of pitch, of syllable length and segment length, of loudness, and of articulatory characteristics in various combinations. But none of these are included in the definition of accent. In other words, accent is ineffable. It plays no part in the phonological analysis of utterances; its place is in the lexicon. Accent, in fact, is what is indicated by the 'stress marks' in the *English Pronouncing Dictionary*.

Here, clearly, Abercrombie understands *stress* to be a (possible) phonetic *realization* of *accent*, which itself is said to have no phonetic content. Note that for Abercrombie stress does not refer to *one* specific phonetic realization. Rather, various realizations can occur in various combinations. In fact, as we will see below, if we use *stress* as a cover term for *correlates* of accent (rather than just realizations of accent), we must also include *phonological correlates*

(such as, for example, the possibility of a broader range of phonemic distinctions in the accented syllable). Adopting this view, several further questions arise, both with reference to the notion accent and with reference to the notion stress:

(2) Questions about accent and stress
   a. How do morphemes and complex words come to have their accents?
   b. For both of these domains, are accent locations unpredictable or can there be rules that predict where they occur?
   c. What are accents properties of (candidates include vowels, moras, rhymes, syllables), i.e. what is the 'accent-bearing unit'?
   d. What is the domain of accent (candidates include morphemes, syntactic words, prosodic words, larger units . . .)?
   e. How do accents interact with the morphological structure of the word?
   f. Can lexemes be unaccented or have more than one accent?
   g. What are possible phonetic (i.e. non-contrastive, allophonic) correlates of accent?
   h. What are possible phonological correlates of accent?
   i. Is stress always based on accent or can languages have stress *without* having accent (an option which might be likely for languages in which the placement of stress is fully regular and thus requires no lexical marking)?
   j. Are stress properties locally realized on the accent-bearing unit or globally throughout the whole domain, e.g. in terms of rhythm?
   k. Are there good reasons for separating out systems as somehow different if they specifically exploit one phonetic property such as e.g. pitch?

Obviously, we need a *theory* of accent which gives or entails answers to all these (and likely more) questions, as well as a theory of accent correlates. The former theory will involve a *formal notation* involving local 'marks' (often represented with an asterisk, as in Goldsmith 1975, or with a partial or full metrical structure, as in Liberman and Prince 1977; see section 1.3.1).

Whatever the answers to all these questions are (and many of them have received serious attention, elsewhere as well as in this volume), once we adopt the Abercrombian perspective, there is no problem in appreciating how the terms 'accent' and 'stress' *can* be used distinctively, accent being the term for 'substance-free' lexical marks and stress for phonetic and phonological correlates of accent. Van der Hulst (2011, chapter 11, this volume) follows this Abercrombian tradition, as does Fox (2000). This leaves us with the second use of accent, namely as a pitch or tonal unit of intonation. I will return to this usage in section 1.6.

The Abercrombian tradition comes with the use of compound terms like *stress-accent* and *pitch-accent*, corresponding to more traditional terms like

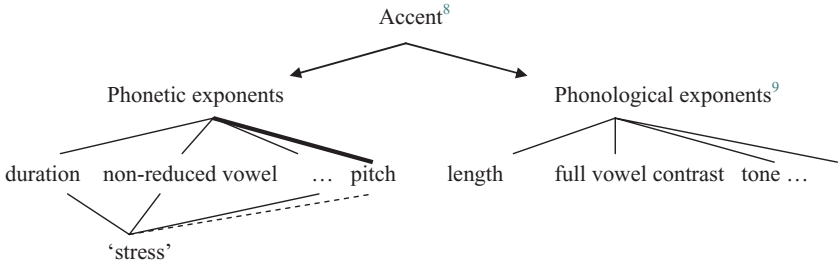
dynamic accent and *musical accent*. This distinction is based on the idea that among the various possible phonetic correlates of accent, an important distinction exists between 'stress exponents' and non-stress exponents (cf. Beckman 1986), the latter characteristically involving the exclusive use of pitch levels or pitch transitions. While it was originally thought that pitch properties were an important part of the set of stress exponents (see, for example, Mol and Uhlenbeck 1956; Fry 1955), it has been argued that this was often an illusion, arising from the fact that stressed syllables of words 'in focus' position function as anchors for intonational pitch movements (see section 1.6). Since descriptions of stress would often be based on the pronunciation of words in isolation, the stressed syllable would be in focus and thus be associated with an intonational pitch movement. This, then, accounts for the pitch properties that are often (wrongly) argued to be an intrinsic part of the stress package.[6] But investigation of stressed syllables in and outside of focus has shown that these pitch properties are in fact very often *not* part of the set of word-level stress properties. When stressed syllables are measured in out-of-focus position they often do not include pitch as a significant factor, but rather comprise primarily the various consequences of *articulatory force* or *hyperarticulation* which typically enhance intensity ('loudness'), duration, fullness of articulation (with consequences for vowel quality and phonation), and more technical notions such as spectral tilt (or spectral balance), *not* excluding somewhat elevated pitch, but *not* the kinds of pitch movements which are introduced by the intonational system as markers of focus (and domain edges) (see Beckman 1986 and Gordon 2011 for relevant discussion and references). This being so, stress-accent and pitch-accent are almost complementary in their use of phonetic exponents of accent, the former showing various effects of articulatory force, while the latter merely or mainly shows a pitch property.

In (3), I display the dichotomy between phonetic and phonological cues of accent with some typical exponents:[7]

[6] Hellmuth (2006) discusses the case of Egyptian Arabic in which *every (prosodic) word* bears a 'pitch-accent', despite the fact that this language is usually taken to be a stress(-accent) language. Since it cannot be the case that every word is 'in focus', pitch, in this case, must be an exponent of word-level accent. See Hellmuth (2006) for extensive discussion of what she argues is a specific typological category.

[7] In van der Hulst (2012), I argue that the term 'stress' still covers too many different uses even if the distinction proposed here between accent and stress is observed, proposing to adopt a set of terms such as *accent* (as suggested here), *phonotactic correlates of accent*, *Edge Prominence*, and *rhythm*, leaving the denotation of *stress* to be the various phonetic effects that results from *articulatory force*, which essentially involves 'stretching' or 'exaggerating' the inherent properties of stressed syllables. In this introduction I will not push for this 'extreme' position, however.

(3)



Here we see that, under this perspective, stress is not a very well-defined property but rather a broad cover term for a set of properties that tend to cluster together. In fact, as mentioned and indicated in (3), we must also include the *phonological exponents* under this umbrella. Van der Hulst (2010) elaborates this point and mentions still other correlates of accent such as those occurring when the accent location plays a role in the anchoring of intonational units (see section 1.6), or in morphological processes that are sensitive to it.[10] Given the wide variety of accent cues (beyond the phonetic exponents called stress), Goedemans and van der Hulst (2009) suggest that many more languages may be accentual than the ones that have thus far been recognized as such. They speculate that accent might be a universal trait of words, but that claim might be difficult to prove wrong if accent can in principle exist without any cue at all (see Hyman, this volume).[11]

[8] Among the exponents, I did not include *rhythm*, which is usually also seen as a 'global' aspect of stress. I will return to this point in section 1.7.

[9] In addition to greater phonological contrast, we can also find greater syllabic complexity. In Dutch, syllables containing a schwa cannot be stressed and they also (with minor exceptions) cannot have a complex onset (see Zonneveld 1993).

[10] When considering such 'extra-phonological' correlates, the question arises whether the correlates in question are correlates of the accent or of its stress manifestation. If stress is a phonetic matter, one would not expect morphology to be sensitive to it, but intonational phenomena could presumably be sensitive to phonetic properties of utterances.

[11] The idea that accent may be a universal property of words comes from a potential identification of the notion 'accent' with the notion *head*. Following principles of Dependency Phonology (Anderson and Ewen 1987; Anderson 2011), the idea might be pursued that all domains *must* have a head, making heads and thus accent obligatory in all words (save minor category words) in all languages. However, a different understanding of accent, also discussed in this chapter, is that accent is a mark of *diacritic weight*, meaning that the accent marks the syllable as *behaving as* a heavy syllable. In that view, there is no issue with words having no accent, or indeed having more than one accent. I refer to van der Hulst (2012) for a reconciliation of these two assessments of the notion 'accent'. In short, diacritic accent, like syllable weight, functions as input to an accent algorithm which can select one accent as the head accent, or can assign a default head accent if no diacritic accent or weight is present. In van der Hulst (2012) I suggest that accentual systems in which accent is both obligatory and culminative are most likely to

The dichotomy between stress-accent and pitch-accent languages raises a further question, namely whether perhaps an even finer array of accent types should be recognized, including 'duration-accent' if there are clear cases in which specifically duration (and little else) signals the accent location. If there are no clear cases of this sort, the next question is why pitch would be special. The answer that is given by several scholars (Poser 1984; Pulleyblank 1986; Hyman 2007, this volume) is that the alleged pitch-accent systems are *tonal systems*, pitch being the core correlate of tone. If, then, one syllable per word has a high pitch (as in Kinga; Schadeberg 1973), rather than saying that one syllable has an accent which has a pitch exponent, it is claimed that one syllable bears a H tone, making such a system a so-called *restricted tone* system (in which, in this specific case, there is no paradigmatic tonal contrast at all). In this view there are only two *prosodic* properties relevant to the discussion here, namely stress (which then becomes a term both for the lexical mark and for its various correlates) and tone. I refer to Hyman (2006, 2014) and van der Hulst (2011) for various arguments pro and con the idea that 'pitch-accent systems' can (and therefore should) be analyzed as restricted tone systems, which implies that the notion 'pitch-accent' is not a third prosodic property that needs to be distinguished alongside stress and tone.

An in-between position would be to analyze a language like Kinga using *both* accent and tone, marking the specific syllable with an accent and then assigning a H tone to that syllable; this is the approach taken in Goldsmith (1975). This view captures that languages like Kinga are similar to stress-accent languages like English in marking exactly one syllable per word as 'special', as well as the fact that languages like Kinga sound like tonal languages and may even have rules that spread the 'H tone' to neighboring syllables. The approach taken by Poser (1984) and Pulleyblank (1986) denies the similarity between English and Kinga.

A slightly less restricted tone system would allow a tonal *contrast* on one specific syllable. Suárez (1983) mentions Northern Pame and Yaitepec Chatino as languages that have a tonal contrast only in the syllable that is said to be 'stressed' (which is the last syllable in both cases). In the Abercrombian way we would call this syllable accented, although it is possible that there are also stress correlates. Indeed, Hyman (1978) calls this type (with reference to other, similar cases) *tonal accent*. Tone, in this, is a *phonological correlate* of accent since it involves contrastive differences in the accented syllable that are not available in other syllables. As mentioned, it is possible that the designated syllable also shows properties that we associate with stress, in which case we

give rise to stress exponents. In all other cases, accentual systems are more likely to give rise to pitch-accent (or tone accent) systems.

have a language with both stress (or stress-accent) and tone (dependent on accent, i.e. tonal accent). This shows that a language can have combinations of different kinds of accent correlates, a fact that we have already established (see (3)).[12]

There are two kinds of arguments in favor of the use of accents for 'pitch-accent languages'. One argument (alluded to above) regards the fact that in the approach of Poser, Pulleyblank, and Hyman there are unexplained similarities between the distribution of stress and the distribution of 'tones' (in restricted 'tone' systems such as Kinga, i.e. the former pitch-accent cases) which involve the specific *edge oriented* (demarcative) locations, as well as the observance of *culminativity* (both stress and 'tone' being restricted to one designated syllable) and *obligatoriness* (each word must have a H tone). These similarities motivate the use of a common element, accent, for both types of cases. To be sure, there appear to be distributional differences between stress and tone (again in restricted systems) in that stress seems to always be obligatory (all, at least major category, words are stressed), while in certain restricted tone systems words can be toneless (i.e. unaccented in the Abercrombian view), 'violating' obligatoriness.[13] A second type of argument against the tonal analysis of pitch-accent systems could be that the use of the notion 'tone' should be limited to cases of a tone *contrast*. If a language marks one syllable per word with high pitch, it is not obvious that this warrants the postulation of a *phonological* entity 'H' (since the pitch quality of the alleged tone is predicable). Analogously, we would not assign a lexical specification '[+long]' to vowels that are predictably lengthened in a certain position (such as finally or before voiced obstruents). Van der Hulst (2011, 2012) exploits such arguments to support the pitch-accent analysis of languages such as Kinga, as well as the notorious case of Tokyo Japanese.

However, there are also arguments against the use of accent for restricted 'tone' systems. As suggested above, the pitch-accent approach does not account for the apparent fact that pitch is special among the potential accentual correlates. The special nature of pitch is explained if we acknowledge that the pitch is really a phonological tone, since we know that among the phonological properties 'tone is different' (Hyman 2011). Another problem with the pitch-accent analysis is that there are several examples of phonetic or phonological properties (not involving pitch) that reflect some sort of culminativity in that they can occur only once per word. Hyman (2007) mentions various examples:

[12] In this connection, Hyman (2007) argues that it is not correct to classify languages as exclusively belonging to one type of system, Rather, in typological studies, we should rather refer to *properties* of languages.

[13] Van der Hulst (2011, 2012) argues that whereas accent may not be an obligatory property, it can be, and that this specific case triggers stress exponents as a mark of 'wordhood' (following the Prague School).

(4) Culminative properties
a. aspiration and glottalization in Cuzco Quechua;
b. length in Mam;
c. mid vowels in the Bantu language Punu;
d. nasalized vowels in Karo.

Although such properties reflect culminativity, it is not obvious that we should see them as correlates of an accent because they do not, as Hyman notes, display *obligatoriness*. Against this objection, we should recall the fact that in languages that have traditionally been analyzed as having pitch-accent, words can certainly be *unaccented* (Tokyo Japanese has unaccented words).[14] Hyman (1981) discusses the case of Somali, in which accent correlates with high pitch (in a pitch-accent analysis), but unaccented words simply lack high pitch.[15] On the other hand, in a stress-accent language, if accents are used only to mark unpredictable locations of stress, words without accent would still always have stress, in a predictable location. This suggests that 'stress' is more than an exponent of accent. Rather, one might argue that it is an independent prosodic system that interacts with accent. If conceived as a post-lexical system, all words would be subjected to it, i.e. words could not be marked as not undergoing it (see van der Hulst 2012). A different kind of problem with an accentual analysis of *all* apparently culminative properties (such as those in (4)) is that in particular cases, independently from these properties, there could be another property such as stress, which may itself require accentual marking in a different location. Hyman (2007) remarks, for example, that in Mam the location of length does not coincide with the location of stress. Can languages have two independent accentual systems, leading to *accentual incoherence*?[16] Examples in which we find conflicting indications for accent locations occur in several Bantu languages in which the initial syllable of the root licenses greater phonotactic complexity than other syllables (suggesting root-initial accent), while at the same time there is a process of penultimate lengthening or penultimate tone attraction (suggesting penultimate accent; see Hyman 2009; Downing 2010).[17] In some Bantu languages, the penultimate

[14] Tokyo Japanese unaccented words have a high pitch plateau extending to the end of the domain, similar to accented words with final accent. However, there are problems with assuming that lexically unaccented words get a final accent *by default*; see van der Hulst (2012) for discussion.

[15] Another alleged problem with an accentual analysis of cases like Tokyo Japanese and Somali is that accents appear to be properties of subsyllabic units like the mora, whereas in stress-accent languages, accents are part of whole syllables (or their rhymes); see van der Hulst (2012) for a dismissal of this problem.

[16] The problem at hand is reminiscent of what Dresher and Lahiri (1991) call *metrical (in)coherence*.

[17] This problem also arises in languages that have vowel harmony, which has also been claimed to be accentual in nature (e.g. in Garde 1968). In Turkish, for example, the first syllable could be claimed to be accented for purposes of harmony (assuming that Turkish vowel harmony is

effect may belong to the phrasal level and thus only hit on phrase-final words, in which case there is no accentual incoherence since different domains may have different locations for accent. In other cases it would seem that we have to reckon with the possibility of the cue for one of the alleged accent locations being a reflection of a historically earlier stage of the language, the second accent location being an innovation. This is what Hyman (2009) suggests for the Bantu case, for which he sees the penultimate effects as an innovation which, although phrasal, in some languages has 'narrowed' down to a word domain process in others.

So, in conclusion, if one would follow the authors who reject the notion accent as useful, we would replace it by either stress (for a language like English) or by tone (for Kinga, Tokyo Japanese, or Somali). In the case of English, we could of course not deny the need for lexical marks in specific cases (notably where the location of stress is not predictable), but these scholars would presumably refer to the lexical mark simply as *stress*, using this term to refer to both lexical marks and the phonetic properties that are said to signal stress:

(5)

Accent (Intonation, i.e. 'pitch-accent')

|

Stress (observable properties)

|

Stress (lexically marked)

Hyman (this volume) represents the view that we only need the notions stress and tone. Both can co-occur within the same language, either independently or in dependencies that seem to go in both directions (stress-dependent tone or tone-dependent stress).[18]

My goal in this section has been to clarify the differences between (1) and (5) and the various considerations that lie behind going with one terminological scheme or the other. The 'debate' continues and the important controversy does not so much lie in the domain of stress systems (not much depends on whether we refer to lexical marking of the stress location as accent or stress), but rather in the analysis of the alleged 'pitch-accent' systems (or, more generally restricted tone systems[19]). Here the difference is theoretical, since (ignoring the intermediate option that uses accent and tone) we *either* use a theoretical entity accent (with a phonetic pitch exponent) or we appeal to tone even where it is not

triggered by a vowel contrast in the initial syllable), which contradicts the usual analysis of Turkish stress as falling on the final syllable.

[18] Hyman (2007) has reservations about the occurrence of tone-dependent stress; also see de Lacy (this volume).

[19] Van der Hulst (2011) suggests ways in which systems that are not traditionally seen as pitch-accent systems, and that seem truly tonal (in the sense of having a tonal contrast) can be analyzed accentually, as long as the 'tonal' contrast is binary (i.e. 'H' vs. 'L').

used contrastively.[20] The key issue is whether there is a *linguistically significant resemblance* between the locations for stress properties and the locations for (non-contrastive) pitch properties, and if so, whether that resemblance should be captured in terms of the notion accent,[21] or rather should be captured by a general theory of prominent positions or culminative phenomena (see Beckman 1999). In favor of the latter view is the fact that languages do display apparently culminative distributions of phonological or phonetic properties for which an accentual analysis would lead to 'accentual incoherence'.

Given the issues considered here, it might be argued that one must keep an open mind and not limit one's study to so-called stress systems (ignoring for the moment that here too it might not always be obvious how that term applies to a given language), but rather include consideration of *all* culminative phenomena so that deeper analysis can reveal which ones truly reflect the role of a potentially unifying notion of accent.

1.3 Stress typology, areal distributions, and acquisition

1.3.1 Stress systems and their formal analysis

In this subsection, before we continue with the various factors that enter into the study of stress, I provide a brief review of the various types of stress that are widely recognized to exist, leaving finer distinctions and problematic issues to the following sections.

Word stress patterns are broadly categorized according to two criteria: boundedness and weight-sensitivity:

(6)

	Weight-sensitive	*Weight-insensitive*
Bounded	English	Finnish
Unbounded	Amele	Turkish

Hayes (1995), van der Hulst (1999), and Kager (1995, 2007) provide thorough overviews of the different kinds of pattern.[22]

Bounded Quantity-Insensitive (QI) stress patterns, extensively reviewed in Gordon (2002a), are those in which the statement of the stress rule need not refer to the quantity, or weight, of the syllables, thereby leaving only domain

[20] Van der Hulst and Smith (1988), a volume on 'pitch-accent systems', contains chapters on systems that mix stress and pitch or tone, which, as pointed out in Hyman (2014), are not all equally likely to fall within the pitch-accent category if this category is to be considered at all.

[21] In this connection it is interesting to note that Kubozono (2011) demonstrates that certain regularities in the location of accents in Tokyo Japanese suggest a rule that is very similar to the English stress rule.

[22] Many of these systems have what is called both primary and non-primary stress. For the moment we focus on *primary stress*.

edges as reference points. These patterns can be divided into four kinds: single, polar (or dual), and rhythmic binary or ternary systems (Gordon 2002a). *Single stress systems* have a single stressed syllable in each word and thus no further rhythmic alternation. Polar stress systems have at most two stressed syllables in each word, at opposite ends of the domain, one primary and the other secondary, with no rhythmic alternation in between. Binary and ternary systems have no fixed upper bound on the number of stressed syllables in a word and place stress on every second or third syllable, respectively, one stress typically being 'primary'. Additionally, systems lacking rhythm may nonetheless have multiple stresses when they place secondary stress on all heavy syllables.[23] They are similar to binary and ternary patterns in that there is no clear principled upper limit on how many syllables in a word can receive stress, but they differ from binary and ternary patterns in that any number of unstressed syllables can occur between stresses.[24]

Quantity-Sensitive (QS) stress systems are unlike QI stress systems in that stress placement is predictable only if reference is made to syllable types, in addition to edges. Because syllable distinctions are usually describable in terms of the quantity, or weight, of a syllable (measured in terms of vowel length, syllable closure, or other prominence-lending properties), such patterns are called 'Quantity Sensitive'. The basic property of QS systems is that certain syllables with certain intrinsic properties (long vowel, syllable closure, high-sonority vowels, high tone, including combinations of these; de Lacy 2007) 'demand' to be stressed, although it may also happen that syllables with certain properties (e.g. containing a schwa) *refuse* to be stressed. Like the QI patterns, QS bounded patterns can be subdivided into single and dual systems. In dual systems, the location of the secondary 'polar' accent is typically not weight-sensitive. When QS systems have stressed syllables throughout the word, these can display a rhythmic (either binary or ternary) alternation that is insensitive to weight or sensitive to weight, or can be weight-sensitive but non-rhythmic. Because of the various possible weight distinctions, each of these subtypes shows extensive variation.

Finally, QS *unbounded* stress systems place no limits on the distances between primary stress and word edges, as primary stress usually falls on the leftmost (or rightmost) heavy syllable. Within the class of unbounded systems it is hard to identify a QI type because, with stress invariably lying on the left or right edge, such cases will be hard to distinguish from QI bounded systems.[25]

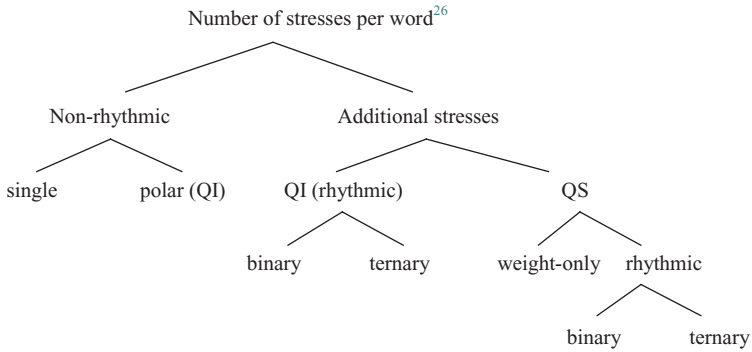
[23] See Goedemans and van der Hulst (this volume) for the fact that the presence or type of weight-sensitivity can differ for primary stress and non-primary stress(es).

[24] The location of non-primary stresses in these languages has been called 'unbounded'.

[25] A possible criterion for discrimination is the patterns of exceptions in QI systems. Van der Hulst (1999, 2012) argues that Turkish, which has exceptional stress locations that can be on any syllable in the word, is for that reason unbounded.

The four-way classification in (6) can thus be augmented by the following array of possibilities regarding the number of stresses per word:

(7)



Stress systems can be still further classified in terms of the precise rules for the location of primary stress. For bounded systems, both QI and QS, we can focus on the *exact location* of stress with reference to the left or right edge of the word. In bounded systems, stress can only fall on a syllable near the edge of the word (initial, second syllable, third, final, penultimate, antepenultimate):[27]

(8) Possible accent locations in bounded systems

Left				Right		
Initial	Second	Third		Antepenultimate	Penultimate	Ultimate
Finnish	Dakota	Winnebago		Macedonian	Polish	French
(σ	σ	σ	. . . . .	σ	σ	σ)$_{word}$

In QS systems the location of stress depends on syllable weight.

In unbounded systems we also find a variety, depending on whether the leftmost or the rightmost heavy syllable is selected for primary stress and depending on the location of stress in words that do not contain a heavy syllable. For example, in Classical Arabic stress falls on the rightmost (or last) heavy syllable, but if no heavy syllable is present in the word, stress is on the first syllable. This is a 'Last/First' system. Given the independence of the heavy syllable rule and what we might call the default rule, we expect four types of unbounded systems to occur:

[26] In foot-based theories, different types of rhythm can be distinguished in terms of the location of the rhythmic beat. If the location is left we get trochaic (binary) or dactylic (ternary) rhythm. If the location is right we get iambic (binary) or anapest (ternary) rhythm. See section 1.7.1 and Hyde (this volume) and van der Hulst (this volume).

[27] These characterizations of stress/accent locations are based on StressTyp, a database for word stress/accent systems of the languages of the world; cf. Goedemans and van der Hulst (2009). Except for some cases that are discussed in more detail, I did not include references for the languages mentioned here and below, all of which can be found in the database that is available online: www.unileiden.net/stresstyp/.

(9) Unbounded systems

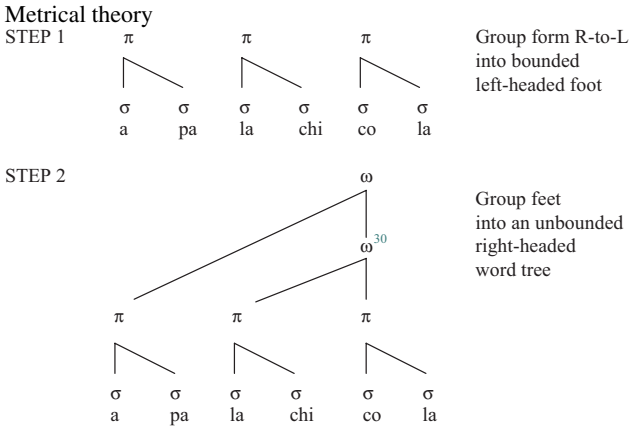
a. Accent the first heavy, or else the first light syllable; e.g. Amele.
b. Accent the first heavy, or else the last light syllable; e.g. Tahitian.
c. Accent the last heavy, or else the last light syllable; e.g. Puluwatese.
d. Accent the last heavy, or else the first light syllable; e.g. Sikaritai.

As shown, all four patterns are attested in the languages of the world (also see Hayes 1995).[28]

The variety of stress system is further compounded by the possibility of regarding a final or initial syllable as invisible ('extrametrical') for the purposes of stress assignment.

In formal terms, the advent of metrical theory (Liberman and Prince 1977) led to an analysis of this variety of stress systems in terms of a recipe for building a constituent structure consisting of two layers, a foot layer and a layer combining feet into a structure that comprises the entire stress domain (in most cases 'the word').[29] The central idea then is that primary stress is derived by organizing the syllables of a word into *headed feet* and, subsequently, feet into a *word structure* in which one foot is the head. The head of the head foot, being a head at both levels, represents the primary stress location. In this view, rhythm is assigned first, while primary stress is regarded as the 'promotion' of one of these rhythmic beats:

(10) Metrical theory



[28] I refer to Goedemans and van der Hulst (this volume) for an overview of the possibilities for bounded QS systems which shows that such systems display the exact same four possibilities that unbounded systems show, albeit within a two-syllable domain either on the left or the right side of the word.

[29] While Liberman and Prince (1977) only deals with English, Vergnaud and Halle (1978) develop their approach into a parametric system for dealing with all stress languages. Their work was further developed in Hayes (1981).

[30] In early versions of metrical theory the constituent corresponding to the word was thought to be recursive, even though intermediate 'word' labels were not specified. In later versions (e.g. Halle and Vergnaud 1987a), the word was taken to be a flat constituent.

Metrical theory thus integrates the full rhythmic organization, including primary word stress and non-primary stresses, into one arboreal structure, even though in this structure there are two levels which directly correspond to the distinction between rhythm (non-primary stresses) and primary stress. With this elegant theory, word stress rules can be formulated as a set of parameters with specific settings for forming a binary branching organization within the word.

(11) *Word stress parameters*[31]
Foot formation
Feet are left-headed/right-headed
Feet are assigned from right-to-left/left-to-right
Feet are bounded/unbounded
Word formation
Feet are grouped into a left-headed/right-headed word tree
Extrametricality
The final syllable is ignored (yes/no)
Weight-sensitivity
A syllable with internal weight must be a head (yes/no)

Extrametricality allows bounded systems to have their stress 'on the third syllable in' (i.e. third syllable or antepenultimate syllable). The distinction between bounded and unbounded systems relies on the option for feet to be bounded (comprising at most two syllables) or unbounded.[32]

An initial success of metrical theory was that examples could be found for the majority of logically possible types (Vergnaud and Halle 1978; Hayes 1981), although not all types turned out to be equally common and some were not attested at all. This led to changes in the inventory of feet (see Hayes 1995) which allowed a better match between the theoretical possibilities and the empirically attested cases (see van der Hulst 1999, 2000 for detailed overviews of these changes). It is not my intention here to discuss these various theoretical issues in any further detail. What our field needs is a thorough review of approaches to word stress/accent that deals not only with the generative traditions but also with other approaches, both earlier and contemporary. Fox's (2000) excellent book contains one chapter on accent which is highly informative, but it is only one chapter in a much broader study of prosodic phenomena.

[31] This set of parameters does not reckon with the distinctions between single and dual systems, nor with the fact that weight-sensitivity can differ for primary and non-primary stresses; see Goedemans and van der Hulst (this volume) for discussion.

[32] Liberman and Prince (1977) propose two planes for the formal representations that underlie stress: the metrical tree and the metrical grid. Prince (1983) abandoned the tree notation, whereas Kiparsky (1979) and Giegerich (1985) abandoned the grid; see van der Hulst (1999) for further discussion of these issues.

1.3.2 The areal distribution of stress types

In addition to the question of which types of stress systems occur in the world, it is also worthwhile to investigate how these systems are distributed in language families and over areas. Van der Hulst *et al.* (1999) provide some maps with the distribution of stress types across Europe, while Goedemans and van der Hulst (2005a, 2005b, 2005c, 2005d), using the StressTyp database, have provided more detailed maps which show such distributions worldwide (also see Goedemans and van der Hulst, this volume). Clearly, with increasing numbers of languages represented in StressTyp2, it will be possible to set up more case studies in which areal properties of stress types can be investigated. Rice (this volume) investigates the areal dimension of stress typology with specific reference to the languages of North America. Hayes (1995) notices some recurrent types in North America which are concentrated in certain areas, cutting across language families. Rice takes a closer look at these cases and discusses in detail the problems that arise in deciding whether an apparent areal distribution is in fact due to language contact or perhaps other factors. Van der Hulst *et al.* (to appear) focus on the areal distribution of stress types on a global level.

1.3.3 Learnability (and acquisition)

While early studies on the acquisition of phonology mostly focus on segmental inventories and the order of development of phonemic contrasts, there is now a significant body of work that deals with the acquisition of stress in three ways (sometimes combined in one study). The first consists of *developmental studies* which chart the different stages toward the full representation of words, including their stress properties (Hochberg 1986; Nouveau 1994; Daelemans *et al.* 1994; Fikkert 1993; and many others). A second strand of work deals with the *logical problem* of stress acquisition. In the context of parameter theory, Dresher and Kaye (1990) make specific proposals about the kinds of cue that are available to the child to set the values of metrical parameters (also see Fikkert 1994; Gillis *et al.* 1995). An extension of this kind of work is to detect cues for foot structure that is not signaled in actual phonetic stress patterns, but rather depends on even subtler cues regarding phonotactic pattern, allomorphic variation, and the like (see Boersma and Pater, to appear). Third, formal computational accounts of learnability, adopting different models (such as finite state grammars, or Optimality Theoretic grammars), have also flourished. I refer to Heinz (2009, this volume) for references.

1.4 Summing up: marks and exponents

It is clear that, despite the terminological differences reviewed in section 1.2, the distinction between content-free formal *marks* on syllables (whether called

stress or accent) and *exponents or correlates of these marks* (both stress and non-stress) captures a real distinction which underlies virtually all work in this domain of research. In fact, in practice we can see research being focused on either one or the other pole.

Over the last few decades, starting with Chomsky and Halle (1968) and continuing to the present day, detailed proposals for assigning 'marks' to vowels or syllables have been developed, all of which assume that it is possible to deal with these marks, irrespective of, and ignoring, their phonetic correlates. Formalisms for assigning stress or accent range from linear to non-linear approaches, each in various varieties, using determinative recipes for assigning marks (as in *SPE*) or structural configurations which embody these marks as 'designated terminal elements' of arboreal structures (as in Metrical Phonology, where the recipes take the form of sets of valued parameters, as demonstrated in the previous section). Alternatively, we find evaluative constraint-based theories (such as *Optimality Theory*) that, while having no bearing on the technical manner in which accent/stress is represented, substitute rules or parameters by *constraints* and theories of constraint-interaction (most notably allowing parochial, i.e. language-specific, ranking); see Prince and Smolensky (1993) and Kager (2007).

In general, it can be said that the study of accent or stress *as marks* has led to a significant understanding of the typological diversity in terms of the possible locations for such marks, leading to such distinctions as bounded and unbounded systems and various subtypes within these (see section 1.3.1). Much research here focuses on understanding the factors that determine the location of marks, which include:

(12) Factors determining primary stress
a. rhythm
b. syllable weight
c. word edges
d. lexical marking (to be discussed in section 1.5)

The role of rhythm is possibly (although not necessarily) manifested in bounded systems in which the stress does not lie on the first or last syllable but one syllable removed from it. In metrical theory, this location is derived by appealing to a rhythmic unit called the *foot*. Syllable weight by itself can also determine a location away from the edge. For example, a penultimate heavy syllable may pull stress onto it and thus away from the final syllable. We also see that both factors (feet and weight) can occur simultaneously (in so-called bounded weight-sensitive systems). The overall relevance of word edges is evident from *all* rule-based systems, either in determining the edge at which the relevant foot is located or, in unbounded systems, in choosing the heavy syllable closest to

the left or right side of the word.[33] Theories differ in how they incorporate these various factors in their formalisms and these formalisms can also differ (trees, grids, neither). The factors in (12) are all *bottom-up* factors in the sense that stress is built on syllables that have rhythmic or weight properties or occur at an edge. Gordon (this volume) discusses *top-down effects* involving the occurrence of intonational pitch movements which may determine or influence the location of stress. For example, a HL intonational unit occurring at the right edge of a phrase may prefer to see its H tone be associated to the *penultimate* syllable to avoid *tonal crowding* on the final syllable. This intonational H tone may then cause a stress which would otherwise be final to 'retract' to the penultimate syllable.

On the side of the exponents, we also see an impressive amount of work being carried out which focuses on the phonetic details of the exponents. The question of the correlates of 'stress' have led to a significant amount of phonetic research (see Lehiste 1970; Fox 2000 for overviews) and more recently many novel contributions have been made (Sluijter and van Heuven 1996; Dogil and Williams 1999; Gordon 2011). An important ingredient of this research is the above-mentioned realization that it is crucial to separate the contributions of word-level exponents and higher-level effects that result from intonational properties. Another issue regards differences in cues for primary and non-primary stresses. Notoriously, especially the latter are hard to measure in objective terms (see de Lacy, this volume). Hualde and Nadeu (this volume) report on the result of experiments regarding the phonetic properties of primary (lexical) and secondary (post-lexical) stress, showing that these differ in their phonetic cues.

These two poles of research into this domain (marks and exponents) fall, traditionally, perhaps in two distinct subdisciplines, namely phonology (marks) and phonetics (exponents). However, many researchers deal with both aspects in studying specific languages, often under the umbrella of what has come to be known as 'laboratory phonology'; see Gordon (this volume) and Hualde and Nadeu (this volume) for some specific examples.

1.5 The role of the lexicon and morphology

1.5.1 Lexical marking

To establish the basic pattern of a culminative property such as stress (or other properties) it is often advisable to first examine words with no or minimal morphological structure. A regularity thus established may be almost 'automatic'

[33] Revithiadou (1999) argues that even in systems with unpredictable, lexical accent marking, edge locations influence possible locations of unpredictable accents.

(have no exceptions) or hold for a majority of cases, while, at the same time, a subset (small, sometimes sizeable) displays a different pattern. For example, while stress on the penultimate syllable may be the majority rule, certain words may have to be lexically marked as having final or penultimate stress (as in Polish; see Franks 1985). A question of some interest is whether exceptions need to be 'close to' the regular rule. Could a language with regular penultimate stress have a subclass of words that have initial stress, or some form of unbounded stress? It has been argued (for example in Idsardi 1992 and van der Hulst 1999) that lexical marking of exceptions has to be visible to the regular algorithm to have effect, which would imply that a right-edge algorithm could not be 'distracted' by marks on the left edge (except in very short words). What is implied here is that the lexical marks are *not* marks of primary stress, but rather marks that indicate that the marked syllable behaves as if it is a 'heavy syllable'.[34] In this sense, lexical marking could be called *diacritic weight* (van der Hulst 1999, 2010). Just as heavy syllables can only interfere with stress[35] placement if they are within the scope of the stress rule, the same would apply to marked syllables. A theory of this kind is developed in, for example, Idsardi (1992, 2009) and van der Hulst (1999, 2009, 2012), but has been implicit in many approaches to the treatment of exceptions (e.g. Franks 1991).

However, in some languages certain classes of words appear to be marked for a rather different stress rule. In Turkish, for example, regular stress is final, but there is a class of words in which stress placement is weight-sensitive (see Sezer 1983). Van der Hulst (1999), however, shows how both aspects can be unified if Turkish is analyzed as an unbounded system with final stress being the default option when no stress further to the left is present in the word due to a special rule or, additionally, the behavior of certain (often bisyllabic) suffixes (see Inkelas and Orgun 2003). More research is needed to assess whether languages can have radically different stress systems, competing as 'co-phonologies' (cf. Shaw 1985) or occurring at different strata.

Gussenhoven (this volume) discusses the treatment of exceptions in the stress system of Dutch within an OT framework, making the significant claim, also pointed at above, that exception mechanisms should not have the power of characterizing exceptions of any sort in a given language since such mechanisms interact with the rules or constraints that are relevant to (the) regular cases. On the other hand, it is known that languages can have a stratified lexicon, part of

[34] In addition to bearing diacritic accent, affixes can also be associated with rules that place, delete, or relocate accents on other morphemes.

[35] Some would say 'accent placement' (see section 1.2), but to simplify the discussion I will henceforth use the term *stress* unless I specifically wish to focus on the different terminological usages.

which is fully tonal, the other part more like a H vs. Ø system, with at least underspecification of L (see Good 2004 on Saramaccan). If stratification can be this different, one might wonder if we won't find a system with two radically different stress assignments. The evidence available in StressTyp suggests that cases in which exceptional locations deviate quite a bit from the regular pattern may not be so rare. Seventy languages (out of 511) are marked as having significant numbers of exceptions. In seven cases these exceptional locations are on the side opposite to the side with regular stress.

In other languages, lexical marking of stress (or rather diacritic weight) is the norm rather than the exception. Such languages have been referred to as having *free stress*, as opposed to *fixed stress* (when stress is rule governed and thus predictable).[36] We find the term *lexical stress* or *lexical accent language* for this type as well. In this case, morphemes may or may not have a lexical mark. What languages of this kind require, then, is a rule which decides which mark prevails in case more than one mark is present, as well as a rule which locates stress in case there is no mark at all. As in the case of the unbounded systems discussed above, in principle, we can expect to find four types of cases here. If the domain of stress is the whole word, stress can be located on the rightmost (or leftmost) mark, or, if there is no mark, on the rightmost (or leftmost) syllable. Both choices appear to be independent, which leads to four types of system, all of which, then, can also be properly called unbounded, because the stress can end up anywhere in the word. An example of a lexical accent First/First system (stress is on the first lexical mark and on the first syllable if there is no mark) is Russian (Dogil 1995). As just remarked, Turkish is an example of a Last/Last system. However, other strategies occur as well. Garde (1965) was a pioneer in pointing out that lexical accent systems are only unpredictable in the lexical marking of the accent properties of morphemes. He showed with numerous examples that once morphemes are combined in a complex word, the selection of which mark qualifies as the primary stress is governed by rules. He showed that there is a small set of resolution strategies that languages employ for this purpose.[37]

It is also possible that marks are only 'seen' by the stress rule when they occur in a smaller domain (2 or 3 syllables) which, effectively, gives us a bounded system in which stress placement is claimed to be unpredictable within a two- or three-syllable window on the right or left edge, except for there being a

[36] If 'fixed' is taken to mean 'rule-governed', it allows cases in which stress is always on the same syllable (when stress placement is weight-insensitive) and cases in which the location of stress is dependent on syllable weight. For the latter case, sometimes the term 'variable stress' is used.

[37] Modern studies in this area are Revithiadou (1999) and Alderete (1999, 2001). The former attributes a special role to the head of the word, whereas the latter considers roots to have a special status.

default clause which applies if there are no lexical marks within the window. An example of this type is Modern Greek (Revithiadou 1999). General studies of lexical accent systems, both bounded and unbounded, are van Coetsem (1996), Revithiadou (1999), and Alderette (1999). The latter two also draw attention to the fact that in a lexical accent system, specific morphemes (both stems and affixes) can come with rules that affect the location of accent. Affixes can insert, delete, or move accents. See Poser (1984, chapter 2) for a detailed study of such phenomena in Tokyo Japanese.

1.5.2 Affix classes

Leaving aside compounds (see Visch 1999), the morphological complexity of words can be relevant to stress placement in several ways. Since the chapters in this volume do not specifically deal with stress–morphology interaction, I will only make a few general remarks here. As is well-known, English has two classes of affixes which differ notably in terms of the way that they interact with word stress placement. A distinction can be made between words with affixes (often called stress-sensitive or Class I affixes) that are subject to the same stress rule that also applies to simplex words, and cases in which the affixes seem to fall outside the scope of the word stress rule (stress-neutral or Class II affixes). Siegel (1974) proposed to order the word stress rule after Class I affixation and before Class II affixation, a proposal that was incorporated into the framework of Lexical Phonology, which extended this idea of level ordering to other phonological processes (Kiparsky 1982, 1985).[38]

When, for example, stress is located on the right edge, adding a Class I suffix may lead to an apparent 'shift' of stress, as in (13):

(13) [condénse] → [[condens]átion]

However, there is no stress *shift*. Rather, the stress on the base, *condénse*, is 'silenced' and a new stress, assigned by the same rule, is placed on the penultimate syllable of the larger word. The silenced stress on the syllable /dens/ may then surface as a non-primary so-called 'cyclic' stress:

(14) [condénse] → [[condèns]átion]

The idea is that the stress that is assigned in the last *cycle* prevails over previously assigned stresses, which Chomsky and Halle (1968) implement with a *stress lowering convention*. If, as in *SPE*, we assume that stress is indeed assigned

[38] Halle and Vergnaud (1987b) contest the claim that affixes can be grouped in blocks like that and suggest that the stress behavior of affixes is more like an idiosyncratic property of the affix; see also Fabb (1988).

cyclically (see also Kiparsky 1979), complete stress silencing could be regarded as the result of 'forgetting' that there is an embedded base:[39]

(15) [condénse] → [[condéns]átion] → [condensátion]

Now, preservation of stress on an embedded cycle is more obviously the case when a Class II affix is added because addition of such an affix does not trigger an application of the stress rule on the newly formed word. Compare in this respect addition of class I suffix *–al* and class II suffix *–hood*:

(16)
a. [párent] → [[parént]al] (Class I)
b. [párent] → [[párent]hood] (Class II)

In the former case (Class I), the stress on /en/ results from applying the stress rule to the whole word. In this case, the stress in the embedded word on /pa/ does not survive because it occurs in a clash with the new primary stress, especially since it occurs on a light syllable, which is not the case in *condensation*, where the syllable is closed.[40] These brief remarks are not meant to suggest an analysis of English stress, which is a highly complex system (see Fudge 1984; Kager 1989; Hammond 1999; Burzio 1994; Pater 2000). This is true, first, of the rule that governs the location of primary stress (which makes English a prime candidate for a stress-*accent* language), but also with regard to non-primary stresses which, in addition to displaying cyclic effects, are sensitive to syllable weight. Also, initial syllables tend to have a secondary stress, which qualifies English as a language with polar secondary stress and weight-sensitive rhythm.

To make a connection with lexical marking, it could be that cyclic non-primary stresses only occur in languages in which the location of stress is heavily dependent on lexical marking,[41] which makes stress a lexical rule, as opposed to a post-cyclic or post-lexical rule, perhaps even implying that words are lexically stored *with* their stress pattern in place (see Brame 1974).[42] In this view, cyclic stresses 'shine through' because they are an intrinsic part of the embedded unit as it is stored in the lexicon. Related to this is the approach which, rather than seeing the embedded unit as containing a lexical mark that

[39] I here ignore the effect of a predictable initial secondary stress; see below.

[40] Many have argued that the extent to which Class I affixes respect the stress pattern of their base is highly variable (Fudge 1984; Pater 2000). We would be inclined to call Class I affixes 'cyclic affixes'. However, in some approaches (e.g. Halle and Vergnaud 1987a, 1987b; Halle and Kenstowicz 1991), Class II affixes are called 'cyclic' because these affixes, as a rule, respect their base as a fully spelled-out 'cycle'.

[41] Chung (1983), however, analyzes stress in Chamorro showing cyclic effects in a language with highly predictable stress.

[42] This might be related to Bybee *et al.*'s (1998) observations about unpredictable stress having more exponent effects.

underlies its stress, accounts for cyclic stresses by assuming that the words in question have lexicalized the segmental *effect* of stress, which in English would be 'full vowel quality' (Bolinger 1981; Kager ms.). In this view, which assumes that many alleged full vowels are really schwas, cyclic stresses would effectively occur on syllables that do not have schwa vowels and are thus phonologically heavy. A problem is, however, that even when vowels are full, they do not necessarily bear stress, as shown by the pair *prodúce* vs. *pròtráct*, both of which have a full vowel in the first syllable, while only the second word has a secondary stress on the first syllable. It would seem, then, that an account of such differences (if indeed they are stress differences) must make use of lexical marks for secondary stress (see section 1.7.1).

Much of the preceding discussion assumes that stress in English is assigned by rule (at least to each newly formed word). One could also argue that in languages such as English where stress placement is irregular (depending on lexical marking and morphology), *all* stresses are based on lexical marks in morphemes and that the stress system is one in which the rightmost or leftmost lexical mark is interpreted as primary stress, with marks to the left or right being potentially interpreted as secondary stresses. On this account, even English could count as a lexical accent language (analogous to the analysis that Revithiadou 1999 gives for Greek) and would belong in the family of cases discussed in the previous section.

Finally, we must reckon with the effect of highly complex morphological systems that occur in so-called *polysynthetic* languages. It is to be expected that languages with very 'long words' will show certain effects (such as the division of long words into several prosodic domains) that are absent in languages with shorter words. It is striking that many of the cases in which Hayes (1995) reports that words have 'no primary stress', or 'multiple equal stresses', occur in languages with very long words (cf. van der Hulst 1997).

In conclusion, despite many insightful case studies and general studies, a comprehensive typology of the interaction between stress or accent and lexical or morphological factors appears to be absent at the present time.

1.6 Intonational pitch-accents

Returning to the topic of section 1.2, let us now turn to the use of the term 'accent' that lies on the other side of (i.e. 'above') stress, as in (1). Here, we are dealing with a rather different notion of accent which is far from abstract or devoid of phonetic content. Rather, this use of accent refers typically to a perceptible intonational unit, which hooks up with the stressed syllable, which Bolinger (1972, 1985) calls a 'pitch-accent', a term that has also been adopted in autosegmental approaches to intonation following the lead of Pierrehumbert (1980).

The correlation between stress and (intonational) pitch-accent is not a necessary one. Stressed syllables are usually linked to an intonational pitch-accent under specific circumstances, typically when the word that contains the stressed syllable is part of a *focus domain*.[43] One can imagine that proponents of the scheme in (1), which involves the use of pitch-accent for cases in which accents are correlated with pitch at the word level, would prefer to avoid the term 'pitch-accent' for intonational events and instead use 'tonic accent' or 'intoneme' in this case. Once again we realize that students of stress and intonation must be careful in their use or understanding of terminology.[44]

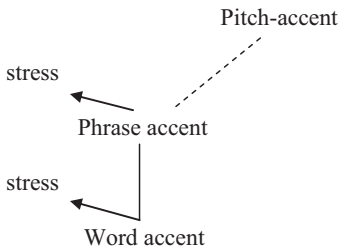
The relationship between word stress and intonation raises various further issues. First, as implied above, not all word stresses correlate with intonational pitch-accents in a language where focus is the driving force. Rather, when several words together make up a phrase which as a whole forms a focus domain, only certain words, often just one, can function as an anchor for the pitch-accent that serves to mark that the phrase is in focus. This entails that there must be rules which determine which words within a phrase have this privileged status. Such rules are often called *phrasal stress rules* (or, again, phrasal accent rules), such as the *nuclear stress rule* in *SPE* which picks out the last (major category) word in the phrase, although there is an extensive literature on the correctness of this rule (for English), with many alternatives being now available as well as a better perspective on typological differences in this area (see Ladd 2008, chapter 5). Here too, the linear approach of *SPE* has been replaced by metrical approaches (either arboreal or grid-based or both). The distribution of pitch-accents forms an important topic of research and we now know that more is needed to explain their occurrence than phrasal stresses, especially if various kinds of pitch-accent are distinguished, such as the 'nuclear' pitch-accent and pre- or post-nuclear pitch-accents (see Gussenhoven 2004 and Ladd 2008 for general introductions).

Recognizing phrasal stress as a separate category from word stress raises the following question: Do such phrasal stresses have their own set of exponents which are present and detectable even when no intonational pitch-accent is present? Another question for those who distinguish accent from stress at the word level is whether it also makes sense to separate these two notions at the phrasal level, and, if so, whether phrasal accent is built on word accent:

[43] But see Hellmuth (2006) for other possibilities for pitch-accent distribution. Also see Gussenhoven (2004) for a general overview and several case studies.

[44] I am not excluding that some scholars (e.g. Jassem and Gibbon 1980) take *accent* to refer to *all* phonetic correlates of stress (both at the word level and intonation level), in which case 'stress' has become the abstract mark, possibly lexically marked, and 'accent' the phonetic correlates. This view is radically opposite to the one we discussed earlier and these two views can therefore not be reconciled.

(17)



I refer to van der Hulst (in prep.) for the point that the culminative properties of words and phrases are indeed parallel and that in languages such as English and Dutch phrasal prominence involves the notion of accentuation (phrasal accents being built on word accents), while in other types of languages (such as the Romance languages or Bengali; Ladd 2008) intonational units are anchored to phrasal edges.[45]

Another aspect of the relationship between word stress-accent and intonational pitch-accents that I have already commented on is that the dependency between them is not always bottom-up as implied thus far. As Gordon (this volume) shows, we must also reckon with cases in which the location of intonational pitch-accent seems to synchronically determine the location of word stress, such as Chickasaw (Gordon 2003). (Here I added 'synchronically' because, as Gordon shows, this particular dependency also has a diachronic importance in the study of the historical emergence of word stress; cf. Hyman 1977.) Top-down effects can even be more dramatic when the claim is made that an alleged word stress is not present at all and that the impression of word stress is caused by the fact that final syllables of words (typically when

[45] This view actually unifies the two uses of the term 'pitch-accent' as 'pitch correlate of accent'. This seems straightforwardly correct for the word-level notion of pitch-accent, while it could be correct for intonation pitch properties if we say that intonation pitch properties are not anchored in word stress, but rather in phrasal accent, where a phrasal accent corresponds to the stress of words in a certain phrasal position:

```
Word      Phrase
Pitch     Pitch (intonation unit)
  |         |
Accent    Accent
```

(In both cases there could be additional correlates.) The only terminological issue is that in the case of a word pitch-accent system, it is not customary to refer to the pitch properties themselves as pitch-accents, but it would be quite appropriate to do just that. To push this even further, a real phrasal analogue to a word-level pitch-accent system would be a system in which, at the phrasal level, all focused phrases receive a *predictable* pitch event. A language like English, in which there are various contrastive phrasal pitch movements would be the proper analogy to a tonal accent language (in which we find a tonal contrast on the accented syllable). That would make Bolinger's term 'pitch-accent' the wrong one for English, and instead the term '(phrasal) tonal accent' should be used.

occurring in phrasal-final position) carry an intonation pitch-accent, not because they have stress, but simply because they are phrase-final. This is one way of analyzing the 'final stress' in French (see Gussenhoven 2004). I also refer to van Goedemans and van Zanten (2007), who show that Indonesian has no word stress, which suggests that what researchers have heard as stress may be the result of intonational effects involving boundary tones.

1.7 Non-primary stress

There is one additional dimension to the terminological web that we need to reckon with. As we have already recognized in sections 1.3.1 and 1.5.2, at the word level many researchers make reference to *levels of stress*, recognizing that words can have a *rhythmic profile* in which various syllables 'stand out' to different degrees. Usually, one 'culminative' stress will prevail over all others (called the primary stress), but other syllables might bear a lesser degree of stress.

1.7.1 Sources of non-primary stress

Non-primary stresses can have several sources:[46]

(18) Sources of non-primary stress
(a) Rhythm
(b) Syllable weight
(c) Word edges
(d) Lexical marking
(e) Cyclic effects

We saw that (a)–(d) factors play a role in the placement of primary stress as well. As in the case of primary stress, these factors occur in a variety of forms and they can be co-present. In fact, in the stress system of English all have a role to play. I mention cyclic effects as a fifth source of non-primary stress. However, if, as argued in section 1.5.1, cyclic stress would be analyzed as a form of syllable weight, (18e) reduces to (18b). When that view is rejected, cyclic stress would remain a fifth factor.

Rhythm results from a binary or sometimes ternary alternation of strong and weak syllables, usually throughout the word, but rarely perhaps in a non-iterative fashion, causing only one non-primary beat. Another dimension of variation results from the fact that rhythm can be *trochaic* (peak first) or *iambic* (trough first), and perhaps additional types can be recognized, especially in

[46] A problem here is whether these non-primary stresses are present in the speech signal or only in the mind of the listener; see de Lacy (this volume).

combination with the binary/ternary distinction (see van der Hulst 1999, 2000, this volume, for detailed discussion). Of specific interest is the interplay between rhythmic stress and the primary stress. Here, a case could be made for dependencies going in either direction (rhythm-based primary stress and stress-based rhythm). Hayes (1995) provides a broad overview of stress systems in which, on his analysis, stress is rhythm-based, although he does also acknowledge cases in which the location of primary stress seems to be independent of rhythm. These options are discussed in Goedemans and van der Hulst (this volume) and van der Hulst (this volume, chapter 11). Both Hyde (this volume) and van der Hulst (this volume, chapter 11) discuss the properties of rhythmic patterns in some detail, proposing accounts of the array of attested patterns from different theoretical perspectives.

Having added rhythm to the picture, another terminological issue again comes up. One could argue that the notion of stress be limited to the most prominent syllable, providing another term such as 'rhythmic beats' to refer to other prominent syllables. More commonly, however, although such a terminological distinction might be used informally, stress is taken to comprise the overall rhythmic profile of words, making reference to primary and non-primary stress (sometimes, as in *SPE*, following Trager and Smith 1951, even differentiating between secondary and lower levels of stress).

It is important, however, to bear in mind that rhythm and (primary) stress are distinct phenomena, the former either feeding into the latter (the standard metrical, bottom-up view) or following the latter (the top-down view proposed in van der Hulst 2009; see Goedemans and van der Hulst, this volume). In the stress-first, top-down mode, rhythm can either be seen as 'rippling away' from the stress (which is called echo accent in Garde 1968), or moving toward it (which gives rise to what has been called either *dual* or *bidirectional* or *polar* systems; see van der Hulst, this volume, chapter 11, for discussion and exemplification). As remarked earlier, while rhythm interacts with primary stress, rhythm is *not* an exponent of stress (as hyperarticulation is). If rhythm would always simply ripple away from the primary stress, it could be seen as an exponent, but that is not the case, since rhythm can come in from the other side, possibly rippling away from the initial secondary stress (see below) or can simply be absent.

The matter of syllable weight has triggered a significant amount of attention. It is intuitively easy to understand that the intrinsic properties of syllables can interfere with the distribution of rhythm.[47] There are two strands of research that elucidate this correlation. Seeing that the location of stress (both primary and

[47] As they do with the location of primary stress, either independently from rhythm or via their influence on rhythm (this choice being dependent on the issue mentioned earlier regarding the possible separation of primary stress and rhythm).

rhythmic) can be dependent on properties of syllables, with certain syllables (called heavy) attracting stress, several questions arise, such as:

(19) (a) What kinds of weight distinctions are attested?
(b) Which properties of syllables can contribute to weight?
(c) Are all weight distinctions binary?
(d) What is the formal representation of weight?

I refer to Davis (2011), Zec (2011), and Gordon (2004) for recent overviews of these and other issues, which are not the primary target of the studies in this volume; see Goedemans (1993, 1996) for the phonetics of weight and the (ir)relevance of onset differences to weight distinctions. There are also accounts which suggest a role for onset properties in stress assignment (Gordon 2004, 2006; Topintzi 2011). An important distinction in categories of weight is that between weight by quantity (CV vs. CVV or CVC) and weight by quality. When stress is sensitive to vowel quality (full vs. reduced vowels, or low vs. high vowels) one often speaks of *prominence- or quality-driven* systems (see Kenstowicz 1997).

A very important aspect of the relationship between syllable weight and stress concerns the question whether there are systematic correlations between specific kinds of weight and specific kinds of stress types. But perhaps the first question that needs to be addressed is whether the fact that syllable weight plays any role at all can be predicted from the inventories of syllable types in any given language. It seems obvious that languages which do not permit either closed syllables or long vowels are very unlikely to have weight-sensitive stress, simply because weight distinctions are lacking. Kager (1992) refers to such languages as being trivially weight-insensitive. However, since one form of weight may lie in the difference between open and closed vowels (open or high sonority vowels attracting stress), or reduced versus non-reduced vowels, no language is strictly speaking trivially weight-insensitive and it is therefore reasonable to look for weight effects, even in strict CV languages (see Kenstowicz 1997).

Turning to languages that do have different types of syllables (CVC, CVV, in addition to CV), it could have been the case that such languages *must* be weight-sensitive, i.e. that stress placement cannot ignore such differences. This does not seem to be the case, and the general assumption is that languages with long vowels and/or closed syllables can be either weight-insensitive or weight-sensitive. Kager (1992) asks whether there are "truly quantity-insensitive languages", implying that weight differences, if present, will always have some influence. A factor that we must reckon with here is that primary stress and rhythmic stress might respond differently to weight (see Goedemans and van der Hulst, this volume). If rhythmic stress is more likely to be a 'low-level'

automatic effect, it is perhaps also more likely to be sensitive to intrinsic differences between syllables, and it is thus worth investigating whether non-primary, rhythmic stress will always be sensitive to weight differences, whereas primary stress (perhaps especially if it shows effects of being sensitive to lexical marks and thus lexical as opposed to post-lexical or at least post-cyclic) might be neglectful of weight because it is a more categorial and phonologized process (assuming that phonologization may entail suppressing natural effects that are below a certain threshold). In short, it is worth investigating whether the influence of weight on stress as a natural low-level effect can be more easily ignored by a phonological rule for primary stress than by a phonetic process for rhythm.

Gordon (2002b, 2006) investigates whether there are phonetic differences between phonologically identical syllables that act as heavy in one language but not in another, thus comparing the behavior of identical syllables in different languages. He shows that such differences exist, and this raises the question whether these differences 'existed first' and thus caused certain syllables in certain languages to attract stress, or whether the differences are the result of these syllables being selected for stress.

As we have seen, a major division in stress systems is that between bounded and unbounded systems. Ahn (2000) investigates a number of weight-sensitive unbounded systems and concludes that syllables that are heavy due to having long vowels, CVV (and thus not closed CVC syllables), constitute the kind of weight that attracts stress in these systems. This is an interesting result that clearly shows a typological correlation between certain kinds of weight and certain kinds of stress placement, but it needs to be tested against a larger sample of languages.

Another line of research that investigates the relationship between syllable structure and stress refers to the typological distinction between stress-timed, syllable-timed, and mora-timed languages. An overview of this work can be found in Nespor *et al.* (2011), who make the interesting claim that such distinctions (which have often been called into question because it was deemed unclear what they were based on; see Roach 1982, den Os 1983) relate to the complexity of syllable structure and more specifically to the time interval between vowels as syllable peaks. The three-way distinction can be correlated, Nespor *et al.* show, with the relative complexity of the consonant units that intervene between vowels. If clusters can be complex and thus vary in duration (as in English), a stress-timed rhythm results, whereas syllable-timed and especially mora-timed systems correlate with more regular intervals caused by simpler or no consonant clusters.

Turning to a third factor that impinges on the rhythmic profile (i.e. (18c)), let us recall the fact that in English (and Dutch), which have right-edge primary stress, the left-edge (first) syllable is typically prominent. This is sometimes

called the 'àbracadábra' effect. I have referred in section 1.3.1 to such secondary stresses as 'polar stresses'.[48] The initial strong syllable and the right-edge stress create a 'hammock' pattern (Zonneveld 1982), with possible additional rhythmic beats in between, provided that the string of syllables is long enough. If there are intermediate beats, the initial beat is stronger than those intermediate stresses, which is why the initial beat is called the 'secondary stress' and the other beats the 'tertiary stresses'.

This initial beat *can* be derived rhythmically if it is assumed that rhythm is assigned from left to right in English and Dutch (avoiding a clash with primary stress), while in other cases it is often assigned from the edge where the primary stress is located. These differences (between 'polar' and 'echo' rhythm) are discussed in van der Hulst (this volume, chapter 11), where it is also suggested that the polar beat is not a rhythmic beat at all, but rather an effect of what Moskal (submitted) calls *Edge Prominence*, a strengthening effect that is not atypical of edge syllables.[49] An indication of the independence of the initial beat is that in some languages it can be involved in cases in which it clashes either with the primary stress or with a genuine rhythmic beat. For such cases, I refer to the chapters by Hyde (this volume) and van der Hulst (this volume, chapter 11), as well as Moskal (submitted).

Turning to factor (18d), it is relevant to ask whether non-primary stresses can be *un*predictable and thus lexically specified? Claims have indeed been made that non-primary stresses sometimes need to be lexically specified. Such claims come in different forms. First, there are cases where *real* non-primary stresses are claimed to be lexical. In fact, English may provide a case in point, with pairs such as *prodúce* vs *pròtráct*.

Second, there are cases in which allomorphic variation is due to a syllable-counting regularity which suggests foot structure beyond or independent of the feet needed for stress (see Gonzalez 2003; Vaysman 2009). In these cases the feet needed for the allomorphy do not necessarily account for rhythmic beats and thus are purely motivated to account for the allomorphic variation. This suggests that rhythm can be lexicalized in terms of abstract foot structure, as such conditioning allomorphy, while the language has meanwhile developed a different surface rhythm.

Factor (18e) brings us back to the issue of cyclic stresses, which, as discussed in the previous section, are non-primary stresses that are not due to the other

[48] Di Cristo (1998) also draws attention to such polar patterns.

[49] The rule in question is more complex than stated here. If the primary stress is on the second syllable, the non-primary stress is unlikely to show up. Syllable weight is important here as well. If the first syllable is light and the second heavy, the second syllable may claim the secondary accent. It is open to question whether this rule is sensitive to phrasal context. Chapter 8 of Hammond's (1999) book provides a nice list of the various permutations of stressed and unstressed syllables as a function of weight, and distance from the primary stress in English.

four factors in (18). As suggested earlier, various approaches to such cases are possible, including one which reduces cyclic stress to a matter of syllable weight.

Finally, relating to the question of stress levels, we also need to consider the matter of compound stress. Compounds often require a stress rule that is distinct from the word stress rule and the phrasal stress rule. Typically, compound-internal words whose primary stress is not reinforced as compound stress shine through as cyclic secondary stresses. The question arises as to whether the primary and non-primary stresses of compounds should contribute to the number of stress levels that need to be distinguished. Specifically, is the secondary stress in a compound stronger than the secondary stress in a simplex or derived word, as was suggested in Trager and Smith (1951)? Fox (2000: 127–34) offers a detailed discussion of these issues.

1.7.2 Non-primary stress and intonation

We need to revisit the claim that pitch-accents dock on primary stressed syllables. It has been frequently observed that this is not always the case, i.e. in specific cases the pitch-accent docks on what appears to be the secondary stress of a word:[50]

(20)

a. That chair is made of bàmbóo

```
                                  :
                                 H*L
```

b. A bámbòo cháir

```
     :        :
    H*L      H*L
```

Note that it seems as if the relationship between the primary and secondary stress is reversed in (20b).[51] The reason for alleged stress reversal has been identified as a *stress clash* (between the stress on /boo/ and the stress on /chair/. The stress on *chair* is phrasal and thus stronger, which makes the word stress on *bamboo* 'move over'. The role of stress clash avoidance is widely recognized, so an account along these lines is well-founded (see Nespor and Vogel 1989; Hayes 1984). However, on a different account (Gussenhoven 2004), what happens here is not a reversal of stress, but rather an anchoring of the first pitch-accent on the syllable with secondary stress, the reason for which lies in the preferred

[50] The so-called 'starred tone' is the one that associates to the stressed syllable; cf. Pierrehumbert (1980).

[51] This would also be a case in which we have two pitch accents in one focus domain: a pre-nuclear and a nuclear pitch accent.

separation of the two 'clashing' pitch-accents.[52] If one would maintain that there is, additionally, a stress reversal, this would be an instance of the top-down effect of intonation on stress location (see Gordon, this volume). Cases like this are open to different analyses (stress-based or intonation-based).

1.8 Problems in the study of word stress

Despite the central role of stress research in phonology, there are certain problems that continue to command our interest, especially in the context of the database project referred to in section 1.1; see section 1.9. Some of these problems are briefly mentioned in van der Hulst (this volume, chapter 11) with specific reference to rhythm, while the contributions of de Lacy (this volume) and Gordon (this volume) take these general problems to be their main concern.

As indicated in section 1.2, the student of stress faces serious problems relating to terminology. One implication is that in building a database for 'stress systems' or constructing a theory of 'stress systems', we do not know whether the languages being lumped together truly form a natural class, given that different scholars may be describing different phenomena while using the same term, and vice versa. Of course, this is only partly a terminological problem. It is also a methodological matter, as well as one that depends on one's control of phonetics and one's underlying phonological theory. This calls for extreme caution, which, however, is not (or cannot be) always observed in broad typological studies.

Early on in word stress research a big concern was that there did not seem to be a homogeneous or invariant phonetic characterization of 'stress'. One problem, regarding the role of pitch as a property of stress, was resolved when it was realized that in many cases significant pitch properties associated with stressed syllables are actually properties of only those stressed syllables that end up being linked to an intonational pitch-accent. Additionally, it came to be agreed upon that stress or accent can have different phonetic and phonological properties in different languages which would not have to stand in the way of generalizations about the rule that determines the location of stress or accent, which, after all, could abstract away from the various phonetic properties. Thus, many typological and theoretical generalizations about 'stress or accent locations' are really about the locations and not so much, or at all, about the realizational or phonetic details. Of course, the identification of the location, based on human perception or instrumental measurement, is not always straightforward; different scholars may hear different things, or indeed nothing at all. As Hualde and Nadeu (this volume) point out, such problems often are

[52] Shattuck-Hufnagel *et al.* (1995) is a phonetic study of clash avoidance as an intonationally driven phenomenon.

very different when locating primary stress as opposed to non-primary stress, the former often being easily identifiable, especially in languages in which this location is not entirely predictable. Goedemans and van Zanten (2007) show that in languages with fully predictable (alleged) primary stress, it may in fact not be easy at all to tell what the location is.

But there are other problems which involve the domain of the alleged 'word' stress or accent. There are at least three classes of problem:

(21)
a. Is the domain the whole word or a subpart?
b. Is the domain the morphological word or the prosodic word?
c. Is the domain the 'word' (in whatever sense) or a larger phrasal unit?

Each of these problems can be parceled out into various further problems or questions.

In section 1.5, we addressed the issue of morphologically complex words and here we saw that sometimes stress can be a property of a subpart of morphologically complex words (in the case of Class II affixation) or of designated units such as roots or affixes. In still other cases, where words can be very long, it is conceivable that the morphological word is broken up in various prosodic subparts (prosodic words, perhaps) for the purpose of stress assignment, leading to the apparent fact that a word can have multiple equal stresses.

(21b) concerns another aspect of the domain issue. When stress displays cyclic effects it seems clear that the stress rules must make reference to morphological structure. Reference to lexical information (such as exception marking or reference to word classes) also suggests application to a grammatical or morphological domain. However, when a stress rule applies blindly to 'words', with no reference to morphological structure or lexical information, it is possible that the domain of this rule is post-lexical or prosodic, which calls for a specification of the nature of this prosodic domain. A problem here is that the relevant prosodic domain (such as the prosodic word) might in fact be smaller than morphological (or syntactic) words, as is clearly the case in compounds, but also, as suggested, in words that result from polysynthetic morphology. In other cases, in languages involving 'clitics' the relevant domain may be larger than the morphological word.

Gordon (this volume) addresses the question in (21c). He points out, as others have occasionally remarked, that when one studies the prominence pattern of words, it often happens that words are taken in isolation, which makes it difficult to separate what might be word-level properties and phrasal-level properties. We have already encountered this point in relation to the realization that, in many cases, pitch movements are not intrinsic cues of word stress, but are instead the realization of an intonational pitch-accent which is associated with a specific word within an utterance. There will thus be potential ambiguity if a word is taken in isolation. Gordon pushes this issue one step further by asking

whether the stress of words in isolation is a word stress at all, pointing to the possibility that we are really dealing with a phrasal stress and its intonational correlates. He pursues this point along two lines. First, he suggests that the popular penultimate location of word stress suggests that, in a historical sense, word stresses may be lexicalizations of intonational pitch-accents (see also Hyman 1977). Second, he suggests it might also be the case that alleged word stresses are, synchronically, phrasal effects.

As shown, there are many issues surrounding the notion of domain for word stress which are easier to raise than to answer, and this volume will shed light on only some of these, specifically those in (21c).

1.9 Database applications

The typological diversity of stress systems and, to some extent, the ease with which one can make 'quick' statements about the location of stress (statements which often need to be relativized upon closer investigation) invites 'Greenberg' style surveys in which hundreds of languages are assigned to types. One of the first surveys of this type can be found in Hyman (1977); another such survey (focusing on types and less on 'numbers') is Greenberg and Kaschube (1976). It was to be expected that with the advent of computer use, 'card collections' and 'lists' that those and other stress researchers kept were being replaced by digital records of some sort. In the next sections, I briefly describe two such projects and their merger into one new system. For a more extensive discussion of these projects I refer to Goedemans and van der Hulst (2009) and Heinz (2006).

1.9.1 StressTyp

Work on StressTyp was initiated by van der Hulst in 1991 as a pilot project of EUROTYP (1990–1994), a project on the typology of European languages, financed by the European Science Foundation (ESF).[53] In the course of the EUROTYP project the question regarding storing language data received special attention, and in 1991 it was decided to start StressTyp as a pilot project. The idea was to develop an intelligent filing and retrieval system for data (i.e. rules, generalizations, patterns) on word stress systems. The structure of the records was developed by Harry van der Hulst. From early on, Rob Goedemans has controlled all aspects of the implementation side of the database. The first data for StressTyp were extracted from existing typological studies and, to a lesser extent, from primary sources (grammars and articles devoted to single

[53] The outcome of 'Theme group 9' of the EUROTYP project, which investigated word stress systems in European languages, was published as van der Hulst (1999).

languages). These data were first combined in so-called Data Entry Sheets (basically a paper-and-pencil version of the record structure) and subsequently entered into the database. In a second phase, the information was checked for consistency and correctness by tracing the primary sources of the typological studies, and often by studying additional sources. At the end of this initial phase, StressTyp contained 154 languages. After the EUROTYP project had ended, work on StressTyp was continued, and resulted in more complete coverage of the stress systems of the individual languages, more thoroughly checked records, and the addition of accentual information for 116 additional languages, bringing the total to 270. From 1997 to 2001, StressTyp was included in the Prosody of Indonesian Languages (PIL) project coordinated by Vincent van Heuven, during which time the database implementation was improved and the number of languages went up from 270 to 510. The content of the old records was checked for errors and the language names and affiliations were updated according to the SIL Ethnologue 13th edition standard (Grimes 1996). At this point only a handful of records for languages in StressTyp were based on secondary sources only. Using StressTyp, Goedemans and van der Hulst produced four maps (plus explanatory text) for the *World Atlas of Language Structures* (WALS), each showing the distribution of various kinds or aspects of word accentual systems (see Goedemans and van der Hulst 2005a, 2005b, 2005c, 2005d). StressTyp has benefited greatly from cooperation with the WALS editors. Among other improvements, StressTyp was expanded with two fields for geographical location, and a procedure was developed to draw distributional maps of StressTyp data with the help of the mapping program AGIS. StressTyp is now also included in the *Typological Database System* (TDS), a joint venture of the Universities of Amsterdam, Leiden, Nijmegen, and Utrecht, which aims at the development of a common query interface for several typological databases. A prototype of the system is up and running (http://languagelink.let.uu.nl/tds).[54] To facilitate smooth integration in the TDS, examples in IPA were converted to Unicode and the Ethnologue codes were updated to the 15th Edition (Gordon 2005). To promote the use of StressTyp, various studies were combined in Goedemans *et al.* (1996). A second volume based on StressTyp is van der Hulst *et al.* (2010), containing chapters on all language families in the world. A web version of StressTyp can be found at www.unileiden.net/stresstyp/. StressTyp encodes primary stress and non-primary stress (rhythm) separately[55] in quasi-parametric fields that each have a well-defined and finite set of values. In addition, there are fields for specifying examples (in IPA),

[54] The TDS also contains SyllTyp, another database designed by Harry van der Hulst and Rob Goedemans.

[55] A rationale for this separation can be found in van der Hulst (1996, 2009) and in Goedemans and van der Hulst (this volume), among others.

prose descriptions, syllable structures, morphological structure, stress-related processes, and remarks, among others.

1.9.2 Stress Pattern Database

The Stress Pattern Database (SPD) was developed by Jeffrey Heinz in 2006 and 2007 as part of his dissertation research at UCLA. There are 403 languages represented in the database and 422 accent patterns, of which 109 are distinct. These word-accent systems are collected primarily from the typologies of Gordon (2002a) and Bailey (1995), though they have been supplemented with information in Hyman (1977) and Hayes (1995). SPD is not a replica of StressTyp. First, its technical construction differs. SPD is implemented as a fully relational database using the widely adopted, open-source MySQL database system. Second, SPD uses different descriptions of the documented dominant stress patterns of the world's languages. These are:

(22)
a. a uniform English prose description of the placement of stress;
b. Bailey's (1995) Syllable Priority Code extended to handle secondary stress; and
c. a representation of each stress pattern in terms of a finite-state automaton.

Each of these descriptions is neutral to any particular linguistic theory of stress. There are additional advantages to the finite-state representations, which are discussed in Heinz (2009). Third, the coverage of languages differs, there being an overlap with StressTyp of only about 200 languages. This means that the two databases combined will represent approximately 750 languages, and that every major language (sub)family will be represented. Finally, SPD also includes other information that is specifically relevant to Heinz's research. In particular, SPD includes results of the Forward Backward Neighborhood Learner (Heinz 2009).

1.9.3 StressTyp2

Recently, StressTyp and the Stress Pattern Database have been merged into a new database, StressTyp2 (ST2), with the goals of improving, verifying, and enriching the dataset in a variety of ways and developing a web-based interface that (i) makes the information in ST2 easily available to researchers and citizens around the world, and (ii) meets or exceeds professional and scientific standards. The third goal of this project is to adopt (and, where necessary, establish) best practice for the collection, organization, dissemination,

and presentation of typological data pertaining to sound patterns in natural languages.[56]

Like SPD, ST2 is implemented as a fully relational database within MySQL.[57] There are several advantages to relational databases that are widely acknowledged. They reduce error during data entry. The powerful query language of MySQL permits sophisticated searches. The logical, relational structure of the database permits the automatic generation of different kinds of reports in a variety of formats (XML, HTML, PDF, etc). Examples of the kinds of report that we are especially interested in pertain to generating information about particular languages, or about particular stress systems, patterns, or classes of stress systems. Additionally, since other established linguistic database systems use SQL, it becomes simple and easy for researchers to develop queries across databases to answer questions that formerly required an incredible amount of bookkeeping. For example: What kinds of stress systems are found in syntactic head-first languages?[58] More generally, relational databases permit the kind of cross-classification that yields new insights into natural language. ST2 includes several tables for languages, primary accent patterns, secondary accent patterns, syllable types (relevant for QS systems), and sources. Additionally, there are tables which link this information together; i.e. which establish the records in which tables are related. ST2 also incorporates metadata about the stress systems that can be updated automatically from scripts. The database also includes metadata regarding the changes that are made to the database over time.

The construction of databases adds problems of its own. Since the goal is generally to allow a broad group of users to benefit from the database, the encoding should not be too theory-dependent. But, as is well-known, any classification or description embodies a theory. This is what we might call the database paradox: we construct such systems in order to be able to better formulate and test theories, but in order to build the ideal database we need a complete theory of the subject. In fact, this paradox is a specific instance of a broader one, identified in Hyman (2008: 83) as follows:

> This brings us to the following paradox concerning the role of theory in cross-linguistic research: While one needs theory to describe languages, one has to abstract away from individual theories to evaluate the resulting descriptions. That is, one has to 'normalize' the data according to some general standard that minimizes the differences between the interpretations that different theories accord to the data. The final question is how to do all of the above in such a way that it is clear what would falsify a claimed universal.

[56] The project is a broad collaboration between Harry van der Hulst (University of Connecticut), Rob Goedemans (Leiden University), and Jeffrey Heinz (University of Delaware).

[57] http://st2.ullet.net.

[58] See Tokizaki (2010) and Tokizaki and Kuwana (to appear) for this kind of work.

StressTyp2 will contain various alternative encodings of stress systems, some in prose, some in the forms of quasi-parameters, some in terms of condensed and summarizing codes, and still others in the form of finite-state automata and the strings of stressed and unstressed syllables that these machines permit. Another problem can be called the 'normalization problem'. The information on which StressTyp2 encodings are based comes from many different sources which employ different terminologies, different transcriptions systems, and different ways of being explicit about the morphological structure of words. In addition, there is the problem, already mentioned, that the prominence patterns of words may reflect properties that belong to higher levels, when studied in isolation. Awareness of these issues (and others) makes us careful, but in the end it is crucial to continuously improve the quality of the information based on the experience and feedback of the user group.

1.10 The chapters in this volume

In this section, I will briefly indicate the focus of each chapter as well as points where these foci intersect.

Chapter 2: Larry M. Hyman – Do all languages have word accent?

In his chapter, Hyman discusses the question of whether all languages have accent, where accent is taken to be word stress or, possibly, other phenomena which privilege a single syllable per word. He asserts that it is difficult to address this question without first establishing some consensus concerning what is meant by stress. He adopts a "property-driven" typology, which, rather than pigeon-holing languages and giving them names, focuses on properties. While English represents one end of a continuum where stress is manifested by a wide variety of properties, therefore perhaps being fundamental to its word-level phonology and morphology, there are other languages at the opposite end which "care" much less about stress, e.g. Hungarian and Turkish. Asking whether it matters if accent is "universal" or if it is only very common, Hyman concludes that even if it is not universal, the reason(s) why it is required in many, if not most, languages still deserves an explanation. Hyman proposes a set of recurrent properties or manifestations of stress. With respect to the question whether other phenomena that display some of these 'canonical' properties of stress should be regarded as accentual Hyman remains skeptical. While there is some typological value in grouping together all such phenomena, the question for him is not one of determining what should vs. should not be called 'accent', but rather what properties can be obligatory vs. culminative in marking words and other domains. Rather than taking a strong (and often arbitrary) universalist stand, he suggests that it will be more revealing to map out the diversity – as, for

example, is done in projects such as StressTyp and other typologically based theoretical work.

Chapter 3: Matthew Gordon – Disentangling stress and pitch-accent: a typology of prominence at different prosodic levels

Gordon's chapter explores the relationship between word-level and phrase-level prominence, one of the problematic issues in metrical stress theory raised by de Lacy (this volume). Gordon hypothesizes that the published descriptions of stress serving as the backbone for large typological studies (and the phonological theories based on these typologies) are characteristically based on words uttered in isolation, where the word is equivalent to an utterance. In such cases, he asserts, the reported stress patterns more accurately reflect phrase-level pitch-accents rather than true word-level stress, a distinction that potentially contributes to the cross-linguistic separation of primary stress and rhythm observed by Goedemans and van der Hulst (this volume). Gordon reports on a survey which suggests that languages may be divided according to the relationship between prominence at the word and phrase levels and whether prominence at either level is repelled from the right edge of a word or not. He shows that many languages project phrasal accent in bottom-up fashion, promoting one or more lexical stresses to a phrasal pitch-accent, with a further bifurcation according to whether stress and pitch-accents may fall on final syllables or not. In other languages, the conditions governing pitch-accent placement operate in 'top-down' fashion largely orthogonal to those dictating the location of word-level stress. The asymmetry between pitch-accents and stress in non-finality effects finds an explanation in terms of intonational factors, following a proposal advanced by Hyman (1977). Pitch-accents are most common in words at the right edge of an utterance. Declarative utterances cross-linguistically are characteristically associated with a low final pitch boundary target, while pitch-accents are typically associated with raised pitch. In order to avoid the articulatorily and perceptually dispreferred crowding of a transition from high to low pitch onto a single syllable, the high pitch-accent may be shifted leftward to a pre-final syllable. Because the intonational tones driving a leftward accent shift are present only phrase-finally, we predict not finding systems within which pitch-accent asymmetrically falls on the final syllable but stress docks on a pre-final syllable. The hypothesis that penultimate stress ultimately has its roots in penultimate pitch-accent is consistent with other phenomena, e.g. final devoicing, that are also likely to have originated as phonetically motivated patterns at the phrasal level that have been generalized to apply within a smaller domain. The predictions of the intonationally driven approach to a prominence typology (based on the various logically possible relationships between word-level stress and phrasal prominence) are discussed.

Chapter 4: Rob Goedemans and Harry van der Hulst – The separation of accent and rhythm: evidence from StressTyp

This chapter offers a demonstration of various applications and uses of the StressTyp database. The first part of the chapter presents overviews of the major types of stress systems as these are represented in StressTyp, both in tabular form and plotted in maps. In the second part, Goedemans and van der Hulst focus on the use of StressTyp in providing support for a particular theoretical claim, namely the separation of (primary) stress and rhythm. Many languages display stress patterns that involve a distinction between one primary stress and one or more non-primary stresses (or rhythmic beats). Approaches to the formal analysis of stress patterns differ in various ways, one being whether primary stress and non-primary stress are derived in terms of a single algorithm or two separate algorithms. The chapter supports a theory of word stress that separates the representation of primary stress (called the accent) and syllables that are rhythmically strong, the idea being that the rhythmic beats are accounted for independently, although 'with reference' to the accent location. The authors provide support from StressTyp for several arguments that underlie 'the separation theory'. Goedemans and van der Hulst conclude that there is good empirical support for the decision to separate the treatment of primary stress (accent) and rhythm, despite the fact that in specific stress systems the two can also share resemblances. In the concluding section they mention several examples of such correspondences which they attribute to the fact that primary stress locations may be historically grounded in rhythmic principles or tendencies (as well as in functional factors that relate to edge demarcation), but they maintain that, synchronically, accent location is not rhythm-based.

Chapter 5: Paul de Lacy – Evaluating evidence for stress systems

De Lacy raises the question of how we can be sure that a description of a stress system is accurate and adequate for phonological research. He identifies theoretically derived criteria for phonological evidence and presents a framework for identifying requirements on evidence presented for generative phonological theories, while paring away the influence of performance and non-phonological modules from the influence of the Phonological Module on speech output. De Lacy asserts that obtaining accurate phonological evidence is extremely difficult due to the deeply 'embedded' position of the Phonological Module: phonological outputs are distorted by translations through the speaker's Phonetic Module, neuro-motor interface and articulatory apparatus, the transmission medium, the hearer's/machine's auditory apparatus, neuro-auditory interface, perceptual

system, and phonological system. Other cognitive modules such as the morphological modules and lexicon can also obscure evidence for phonological processes. The chapter focuses on a few core properties of generative theories of phonology, including modularity, L1 vs. L2 status, interfaces with other cognitive modules, and post-cognitive processes, and derives certain requirements on evidence from these core properties. The requirements include demonstrating that evidence for a particular module's state is sourced from a single L1 module (i.e. one speaker), and that the effect of distortions of the phonological output by non-phonological modules and factors must be taken into account. The distinction between requirements on evidence and techniques for gathering evidence is emphasized. For example, one requirement is that a dataset must be generated by a single Phonological Module. The techniques used to ensure this requirement can be many and varied, and change as understanding about the efficacy of certain techniques improves. The requirements on evidence that are identified are not novel or particularly surprising. However, a close examination of a stress description – Araucanian – shows that this case is rife with uncertainties, rendering it difficult to use as phonological evidence. Araucanian has been cited in support of many metrical theories and is a typical description, suggesting that there are many more descriptions that fail to meet even fairly minimal standards set by generative theories of phonology.

Chapter 6: Keren Rice – Convergence of prominence systems?

Rice, working from StressTyp2 and other data, examines an issue that has not been widely discussed in the literature: contact phenomena and loanword data in the description of stress and its transfer/adaptation from one language to another. While there are a number of phonological features that have been argued to characterize the linguistic areas of North America, stress is rarely discussed in the literature as an areal trait, although it is argued to be a feature that is easily shared in contact situations. It is thus worth examining whether there might be borrowing of accent patterns under contact. Rice examines this issue from three major perspectives. She begins with an investigation of loanwords from a European language into the indigenous languages of North America to see if there is evidence that accent might be borrowed in loanwords. She concludes that accent patterns are borrowable. Rice then examines whether accent systems themselves might be borrowed independently of loanwords, providing some evidence for this. Finally she examines some of the linguistic areas in North America to see if there is evidence for contact effects. There are striking tendencies in terms of accent systems in some of the linguistic areas. For instance, in Northern California, many of the languages have Quantity-Sensitive stress systems, with a realization as pitch, and in the South Coast

Range, accent is generally oriented to the right edge of the word. In the Pueblo area, accent is generally oriented toward the left edge with a tonal manifestation. Rice questions, however, whether it can be concluded that contact is the cause of these similarities. She further addresses possible predictions about what might be shared and also examines some of the empirical issues that arise (e.g. the need for basic information to include phonetic correlates, the difference between word- and phrase-level patterns, and the types of social differences between different languages). Her discussion touches on the quality of data sources and availability of data, issues broadly addressed in the chapters by de Lacy (this volume) and Hualde and Nadeu (this volume) as well.

Chapter 7: José I. Hualde and Marianna Nadeu – Rhetorical stress in Spanish

Stress systems with rhythmically alternating secondary stresses have played a major role in the development of metrical stress theory. Hayes (1995: 33), in fact, focuses primarily on such rhythmic systems for his theoretical proposal, stating that "these are the systems that arguably are of the greatest interest from a metrical perspective". However, in several languages that have been taken to possess such rhythmic secondary stress systems, phonetic investigation has failed to find evidence for them. The fact that no empirical evidence has been found to support non-primary stresses raises serious concerns regarding the nature of the evidence that has been used in typological and theoretical work. This can be seen as particularly disturbing because, among those languages that have been claimed to possess rhythmically alternating stress, Spanish, Polish, and Greek have large numbers of speakers and are easily accessible, but, as de Lacy (this volume) points out, for a majority of languages in stress databases we have a single source. If, for languages like Spanish, Polish, and Greek, experimental work has failed to find evidence for rhythmic stress, how much faith can we have in the correctness of the description of the stress systems of less accessible and more poorly documented languages? (De Lacy raises this question also for primary stress in languages where presumably it is not phonologically contrastive.) Hualde and Nadeu take the position that intuitions are worthy of attention to the extent that they are consistent among speakers of the language. They explore the hypothesis that the secondary rhythmic stress patterns that several authors have described for Spanish may have their root in an extrapolation from a phenomenon that is called "rhetorical stress", which is the optional appearance of readily identifiable stress prominence in certain speech styles on syllables that are not lexically designated to carry stress. This phenomenon has parallels in other European languages, such as the "accent d'insistance" of French and "emphatic stress" in Greek. Comparable

phenomena are also the stress retraction rules in rhetorical style in Dutch and German; for references I refer to their chapter. Unlike the Greek "emphatic stress", which is limited in its placement to function words and the initial syllable of content words, Spanish rhetorical stress has a freer distribution and appears to be at least partially related to rhythm, since it is often placed two syllables before the lexically stressed syllable, and not necessarily on the initial syllable.

Chapter 8: Jeffrey Heinz – Culminativity times harmony equals unbounded stress

In this chapter, Heinz provides a formal-language theoretic analysis of simple unbounded stress patterns. The main result is that simple unbounded stress patterns over syllables are of the same formal character as simple harmony systems over consonants and vowels, once the notion that there is exactly one primary stress in every stress domain is factored out. In other words, this analysis shows that long-distance phenomena in two seemingly different phonological domains are actually of the same kind modulo the culminative and obligatory nature of primary stress. One implication of this result is that it simplifies the problem of understanding how simple unbounded stress patterns could be learned. The chapter also demonstrates how insights can be obtained from computational analysis that would otherwise be difficult to obtain. In this case, the unification of long-distance phenomena in different phonological domains was made possible by a computational analysis which emphasizes *what* is being computed as opposed to *how* it is computed. Consequently, the analysis is independent of any particular generative theory.

Chapter 9: Carlos Gussenhoven – Possible and impossible exceptions in Dutch word stress

Gussenhoven examines exceptions to the regular stress pattern in Dutch, showing that the types of lexical exception are limited. It is demonstrated that ungrammatical exceptional stress can be ruled out by an Optimality Theory (OT) grammar assuming free lexical foot marking and a constraint hierarchy that allows possible exceptions to go through, but disallows unattested exceptions. Crucial to the analysis is the assumption that Dutch tense vowels are short (V) when occurring in open unstressed syllables and long (VV) otherwise, and that lax vowels are either short and followed by a coda C (VC) or long (VV). After showing how the regular distribution of stress is accounted for, Gussenhoven reviews nine types of exception and argues that one of the attractive

properties of OT is that it distinguishes between possible and impossible exceptions. Given an appropriately rich input, the interleaving of faithfulness constraints with markedness constraints must yield an impossible structure whenever the markedness constraint outranks the faithfulness constraint, while the reverse ranking will preserve the rich structure. Unrestricted lexical inclusion of foot structure and the suitable ranking of markedness constraints therefore ought to explain the difference between attested and impossible exceptions in Dutch.

Chapter 10: Brett Hyde – Symmetries and asymmetries in secondary stress patterns

Hyde's point of departure is the long-standing observation about the typology of binary stress systems that trochaic patterns are attested in a greater variety than iambic patterns. The typological imbalance is typically described in terms of directional foot construction: trochaic feet can occur in a greater number of directional parsing configurations than iambic feet, but Hyde argues that the imbalance results from the influence of two asymmetrical constraints, STRESS INITIAL and NONFINALITY, which determine the status of peripheral syllables stress-wise.

(23) a. STRESS INITIAL: The initial syllable of a prosodic word is stressed.
b. NONFINALITY: The final syllable of a prosodic word is stressless.

To see why STRESS INITIAL and NONFINALITY are the key to iambic–trochaic asymmetries, it is helpful to focus directly on the distribution of stressed and unstressed syllables, temporarily setting aside feet and their directional parsing patterns. Hyde shows that while patterns that avoid clashes and lapses (patterns based on perfect alternation), whether trochaic or iambic, display symmetry, patterns with clash or lapse are not symmetrically attested. If a trochaic version is attested, its iambic mirror image is not, and vice versa. Hyde points out that since patterns that contain a clash or lapse are not attested in mirror-image pairs, the theory must be able to introduce clashes and lapses only in appropriate circumstances. This is where the asymmetrical formulations of STRESS INITIAL and NONFINALITY play a key role. When a clash or lapse arises near the left edge in an attested pattern, for example, it is always to accommodate an initial stress. It never arises near the right edge to accommodate a final stress. STRESS INITIAL's asymmetric formulation helps to predict just this situation since it requires stress on initial syllables but not on final syllables. Similarly, when a clash or lapse arises near the right edge, it is always to accommodate final stresslessness. It never arises near the left edge to accommodate initial

stresslessness. NonFinality helps to predict this situation, since it can require final syllables to be stressless but not initial syllables. Hyde continues to discuss some problematic cases. He shows that close examination of the descriptive sources suggests that there is good reason to doubt that the crucial cases actually have the alleged problematic patterns.

Chapter 11: Harry van der Hulst – Representing rhythm

Like Hyde's chapter, this chapter provides an account of word rhythm. Here it is assumed, however, that there is an accentual module which pre-selects an accented syllable which functions as the reference point for rhythm. Van der Hulst provides a brief overview of the accentual module, after which the chapter focuses on the rhythmic module which is fleshed out in terms of a grid-only approach. A distinction is made between simple rhythm and complex rhythm, the latter mostly involving so-called 'bidirectional' systems. The proposal is made that bidirectionality is a consequence of a 'polar rule' which places a beat on the edge opposite to the accent that underlies the primary stress, creating a 'hammock pattern'. Subsequent rhythm operates in the valley between these two prominent peaks and can echo either one or the other. Van der Hulst also discusses a subclass of the complex systems, so-called 'clash systems', proposing that these systems too can be seen as having two opposite prominence peaks, with rhythm bouncing into the lesser, polar peak. He proposes a specific set of rhythm parameters which account for all and only the attested patterns.

1.11 Conclusions and perspectives for future research

In this chapter it has been my goal to set the stage for the ten chapters that follow. We have reviewed a host of issues that deserve our attention in studying word stress systems. In various places, I have indicated that additional work is needed and it is our hope that the StressTyp2 project will help researchers in addressing various angles on word stress. Here I summarize some of these which stand out:

(24)
a. the nature of exceptionality and thus the role of the lexicon
b. the interaction between morphology and stress
c. the nature of unbounded systems
d. the separation of word-level and phrase-level prominence properties and their interaction
e. the correlation between weight types in relation to other aspects of stress such as rhythm, and (un)boundedness
f. the relative independence of primary stress and rhythm

g. the role of accent as driving surface prominence phenomena
h. the formal nature of stress rules or patterns
i. the areal distribution of stress types and consequences of language contact
j. the diversity of approaches outside generative quarters
k. what standards to apply before accepting descriptions as evidence

Undoubtedly, other issues or concerns can be added (such as the function of word stress in sentence parsing and lexical access; historical change), but here I have limited myself to topics that are dealt with in the chapters in this volume. The study of word stress remains of great interest, presenting researchers with broad typological diversity and intriguing complexity and as such it will continue to command our interest and attention for a long time to come.

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2 Do all languages have word accent?

Larry M. Hyman

2.1 Introduction

The purpose of this chapter is to address the question: Do all languages have word accent?[1] By 'word accent' (henceforth, WA), I intend a concept a bit broader than the traditional notion of word-level stress-accent, as so extensively studied within the metrical literature. I will thus use the term as follows:

(1) Word accent refers to the phonological marking of one most prominent position in a word.

The question in my title is thus intended to mean the following:

(2) Do all languages phonologically mark one most prominent position per word?

As defined, WA is designed to be more descriptive and inclusive than 'word stress', which refers to a common type of prominence marking, typically analyzed as the headmost syllable of a metrical structure (cf. §2.2). Even so, the claim has been made that all languages have word stress, and thus necessarily WA:[2]

(3) A considerable number (probably the majority, and according to me: all) of the world's languages display a phenomenon known as *word stress*. (van der Hulst 2009: 1)

On the other hand, a number of scholars have asserted that specific languages lack word stress, if not WA in general. This includes certain tone languages in Africa, but also languages without tone:

[1] This chapter is a second revision (April 2012) of an oral paper presented at the Conference on Word Accent: Theoretical and Typological Issues, University of Connecticut, April 30, 2010. I would like to thank Harry van der Hulst and two anonymous reviewers for their helpful comments on the earlier drafts.

[2] Harry van der Hulst has since indicated to me via personal communication that he meant 'word accent' in the more general sense intended in this study.

(4) [In Bella Coola there is] . . . no phonemically significant phenomena of stress or pitch associated with syllables or words . . . When two or more syllabics occur in a word or sentence, one can clearly hear different degrees of articulatory force. But these relative stresses in a sequence of acoustic syllables do not remain constant in repetitions of the utterance. (Newman 1947: 132).

In fact, many languages do not provide unambiguous evidence of WA – or even words (Schiering *et al.* 2010). In many cases the interpretations have been theory-dependent and highly personal: some people see (or hear) stress where others do not. Given this fact, it will be extremely difficult to demonstrate to the satisfaction of all that WA either is or is not universal.

The strategy which will be adopted in attempting to answer the question in (2) is as follows. We will start in section 2.2 by defining stress-accent and then discuss what the properties of a 'canonical' stress-accent system might be. In section 2.3 we will then consider languages which diverge in one or another way from the canons established in section 2.2. In section 2.4 I ask whether other distributional effects of positional prominence qualify as WA, followed by cases of co-occurring tone and WA in section 2.5. A brief discussion in section 2.6 concludes the study.

2.2 Defining stress-accent

In this section I will be concerned with how to define stress-accent (or *stress* for short), given the tremendous variation one finds in metrical stress systems (see especially Halle and Vergnaud 1987 and Hayes 1995). Let us start with the more basic question: How does one recognize stress when one encounters it? To answer this, consider what the most unambiguous stress system might look like. It might be a language with the following properties:

(5)
a. Stress location is not reducible to simple first or last syllable (which could simply represent a boundary phenomenon).
b. Stressed syllables show positional prominence effects:
   i. Consonant, vowel, and tone contrasts are greater on stressed syllables.
   ii. Segments are strengthened in stressed syllables (e.g. Cs become aspirated or geminated, Vs become lengthened, diphthongized).
c. Unstressed syllables show positional non-prominence effects:
   i. Consonant, vowel, and tone contrasts are fewer on unstressed syllables.
   ii. Segments are weakened in unstressed syllables (e.g. Cs become lenited, Vs become reduced).
d. Stress shows cyclic effects (including non-echo secondary stresses).
e. Stress shows rhythmic effects lexically/post-lexically (cf. the English 'rhythm rule').

f. Lexical stresses interact at the post-lexical level, e.g. compounding/phrasal stress.

g. Lexical stress provides the designated terminal elements for the assignment of intonational tones ('pitch-accents').

h. Other arguments that every syllable is in a metrical constituent which can be globally referenced.

The above stress system sounds a lot like English, which we can therefore take it to be. What makes metrical stress so unambiguous in English is that it is multiply invoked throughout the phonology: English 'cares' a lot more about stress than many other languages. The key notion here is *phonological activation*:

(6) Clements (2001) argues for a general principle of representational economy according to which features are specified in a given language only to the extent that they are needed in order to express generalizations about the phonological system. (Clements 2005)

As a result of the thorough-going phonological activations in (5), it would be folly to attempt to analyze English without stress. At best, major generalizations would be missed. Let us therefore assume that there is no disagreement of interpretation; that all researchers agree that English has word stress. The issue of interpretation may become more relevant when approaching systems which, unlike English, show only a mild interest in stress. Thus, compare Hungarian, where "stress does not play a significant role in the word level phonology" (Kenesei *et al.* 1998: 428), and Turkish, where stress can be identified mostly on the basis of F0 (Levi 2005), but not a single phonological constraint or rule refers to it.[3] We thus have a cline in terms of activation: some languages such as English make stress the central issue of their word-level phonology and morphology, while stress can be quite marginal in other languages such as Hungarian and Turkish.

Many scholars have been impressed with the more extensive effects of stress in Western Germanic as opposed to, say, Spanish (cf. the elusive 'stress- vs. syllable-timed' distinction). Thus, van Coetsem (1996: 39) speaks of two kinds of prominence: 'dominant' vs. 'non-dominant'. Although the distinction is sometimes presented as one of realization (e.g. concerning whether or how much stressless syllables are 'reduced'), the alternative is to view the putative differences more generally in terms of the degree of phonological activation.

[3] Pointing out that the phonetic realization of WA bears some resemblance to Japanese, Basque, and Serbo-Croatian, Levi (2005: 94) in fact claims that Turkish should be called a 'pitch-accent language'. As in Beckman (1986), this assumes a typology based on phonetic implementation rather than linguistic function. For a critique of the practice of forcing languages into types and the resulting incoherence of the concept of 'pitch accent', see Hyman (2009, 2012) and below.

Languages which exploit metrical structure for multiple purposes, as in (5), will exhibit the kind of 'metrical coherence' found in Germanic (Dresher and Lahiri 1991), van Coetsem's 'dominant' type of prominence.[4] Languages such as Hungarian or Turkish seem different because their metrical structure has little or no relevance outside the stress system itself. The contrast with English, whose phonology cares so much about stress, is quite striking. At the other extreme, Bella Coola cares so little that we cannot even determine if it has word stress at all.

Of course, all of the above assumes that we can adequately define what is vs. what is not a stress system. Approaches to defining stress-accent have been of three types:

(i) The phonetic approach is concerned with the realization and perceptibility of stress. The typical question is how stress is phonetically manifested. The acoustic properties of F0, duration, and intensity are typically investigated, as are the articulatory gestures involved in enhancing the properties of stressed syllables (cf. Lehiste 1970; Beckman 1986; Levi 2005).

(ii) The functional approach typically focuses on the communicative motivations of stress-accent (cf. Garde 1968; Martinet 1954, 1961). The obligatory and culminative parameters of 'one and only one primary stress per word' are said to communicate the number of words that are present. If primary stress is 'fixed' on the same syllable in every word, e.g. first or last, it assumes also a 'demarcative' function, indicating where the actual word boundaries are. Especially when 'echo stress' iterates, such rhythmic marking enhances the other functions, as syllables build up to or away from the primary stress.

(iii) The formal approach is interested in stress in terms of its organizational or structural properties. Although not opposed to the other approaches, it is possible to study the formal properties of stress without addressing communicative or phonetic implications. In this sense, we could also refer to such approaches as 'phonological' or perhaps better 'grammatical', as phonology is a component of grammar. In this approach, emphasis is on the construction of metrical constituents (e.g. feet), often with regard to other aspects of grammar (cf. Halle and Vergnaud 1987; Hayes 1995; among others).

Despite considerable overlap in actual practice, the questions raised by each of the three approaches can be quite different: What are the acoustic correlates

[4] Hyman (2009: 217) presented the multi-activated system in (5) as a possible prototype for stress, since it has almost everything except the proverbial kitchen sink. While the extensive stress-marking of English might serve as a practical reference point for comparison with other potential stress systems, the fact that so much of the system has been lexicalized does not make it a good candidate for prototypicality. Instead, an attempt to define what might be a 'canonical' stress system is provided in (10) below.

of stress across languages? What is the relative perceptibility of the different acoustic correlates of stress-marking across languages? What is the range of structural rules assigning stress across languages? All of this assumes that we know stress when we see/hear it. In Hyman (2006: 231, 2009: 217), the following, generally accepted, definition of stress was presented:

(7) A language with stress-accent is one in which there is an indication of word-level metrical structure meeting the following two central criteria:
   a. obligatoriness (OblHead): every lexical word has at least one syllable marked for the highest degree of metrical prominence (primary stress);
   b. culminativity (CulmHead): every lexical word has at most one syllable marked for the highest degree of metrical prominence.

(8) In addition to meeting both of these criteria, another inviolable property of stress systems is that the stress-bearing unit is the syllable . . . (Hyman 2009: 217)

As a result of combining the properties in (7a, b), every lexical word must have ONE AND ONLY ONE (primary) stress, the prosodic head of that word. The above seems to be a very workable definition characterizing a common and recognizable prosodic type known as stress-accent. (8) further specifies that the stress-bearing unit must be the syllable (cf. Hayes 1995: 49). As a definition, (7) and (8) represent a MINIMUM that any system must meet in order to be stress-accent. Much more can of course be said about what to expect of a stress system – and, as we shall see, there are word-prosodic systems that do not quite meet one or another of the above definitional requirements. Finally, note that these criteria only establish whether a language has a stress-accent system. They have nothing to say about whether it also has tone, an independent parameter, as in Swedish and Mandarin.

In order to address the question of whether all languages have stress-accent (or some more generalized notion of WA), it is helpful to ask in advance why one might even suspect such a potential universal. It is in this connection that Greville Corbett's "canonical approach to typology" comes in handy:

(9) The canonical approach means that I take definitions to their logical end point, enabling me to build theoretical spaces of possibilities. Unlike classical typology, only then does one ask how this space is populated with real instances. The canonical instances, that is, THE BEST, CLEAREST, INDISPUTABLE (the ones closely matching the canon) are unlikely to be frequent . . . Nevertheless, the convergence of criteria fixes a canonical point from which the phenomena actually found can be calibrated, following which there can be illuminating investigation of frequency distributions. (Corbett 2007: 9; my emphasis – LMH)

While the combination of properties in the system presented earlier in (5) might be considered to be the most 'indisputable' case of stress-accent in the sense

of having the most activations, it is not functionally canonical. Following the Prague School view (Jakobson 1931; Trubetzkoy 1939; Martinet 1954; Garde 1968), let us assume that the core function of stress-accent is to identify and mark off major category words within utterances. In order to be able to tell how many words there are in the utterance and where the word boundaries are, canonical stress should therefore be:

(10)
a. obligatory : all words should have a primary stress
b. culminative : no word should have more than one primary stress
c. predictable : stress should be predictable by rule
d. autonomous : stress should be predictable without grammatical information
e. demarcative : stress should be calculated from the word edge
f. edge-adjacent : stress should be edge-adjacent (initial, final)
g. non-moraic : stress should be weight-independent
h. privative : there should be no secondary stresses
i. audible : there should be a phonetic cue(s) of the primary stress

The two properties in (10a, b), obligatoriness and culminativity, were already presented as definitional in (7): if metrical structure does not define one and only one primary stress, then the system is not stress-accent. The properties in (10c–h) are canonical, designed to enhance the proper function of word demarcation within an utterance. For this purpose stress-accent should be predictable (10c), i.e. assigned by general rule, rather than lexically idiosyncratic. As this might include reference to morphology, (10d) further stipulates that grammatical information should not be required in the canonical case. Since the function is to mark off words, the predictable stress should be demarcative (10e), i.e. calculated from a word edge. Given that there could be varying numbers of prefixes and/or suffixes in different words, assigning primary stress instead to the root syllable would not be canonical.

(10f) stipulates that the primary stress should not only be calculated from the edge, but also be edge-adjacent: Initial and final stress are more canonical than peninitial or penultimate.

(10g) says that stress should be assigned without regard to syllable weight (moras) – or any phonetic or phonological criterion. Weight-sensitivity has the potential to result in cases where one cannot unambiguously determine the word segmentation from the output. To illustrate less than perfect demarcation, Martinet (1961: 87) cites the sequence *bónacalígula*, which has two possible parsings: *bóna Calígula* (the correct one) and **bónaca lígula*.

(10h) identifies secondary stresses as non-canonical. Most egregious would be cases of unpredictable secondary stresses, as in English *ínsèct* vs. *súbject*. While it might seem that building iterative feet could be an enhancement of the primary stress, the potential would be there for a secondary stress of

one word to detract from the primary stress of an adjacent word. It might therefore be most effective to have not only one primary, but one total stress per word.[5]

Finally, (10i) simply says that the primary stress should be phonetically detectable.

Taken together, the canons conspire to impose 'biuniqueness' on stress-accent: one should be able to predict the primary stress from the word boundaries, just as one should be able to predict the word boundaries from the stress. What this means is that perfect demarcative stress is canonical, and anything else represents a divergence from one or more of the canons. In support of this Praguian position, Hyman (1977, 1978) and Bybee *et al.* (1998) argue that languages first develop demarcative stress, historically, which then can be subjected to further restructuring. Thus, unpredictable primary or secondary stress would diverge from the core function of demarcation and is hence less canonical. As in canonical typology in general, few, if any, languages will meet all of the canons at once. Thus, Bybee *et al.* also point out that it is in languages where stress is not fully predictable that multiple phonetic marking of stress tends to occur. Where stress is canonically demarcative and edge-adjacent, packaging and recognition will be more transparent; where it is unpredictable, more extensive effects and greater non-canonicity is observed.

Turning to the question of universality, the Praguian functional approach gives us a window into why languages might require some form of WA: van der Hulst's position in (3) comes down to a claim that all languages need to mark off words, in other words that it is impossible for all positions (e.g. syllables) in a word to be of equal prominence. Not to have a primary stress means not to be a word. It turns out that other systems are more seriously non-canonical in the sense of violating the definitional properties in (7), (8), and (10a, b), to which we now turn.

2.3 Divergences from definitional stress-accent

If we attempt to generalize the definition of stress-accent to all kinds of potential WA, problems arise having to do with each of the following five elements mentioned in (7) and (8):

[5] This is perhaps the most debatable property in (10). While incorporating all syllables within a hierarchized metrical structure might better indicate the internal morphological structure of the word, the proposal in (10h) is that a simple contrast between primary vs. no stress better satisfies the canonical function of stress, which is to be demarcative. I take no position as to whether this means a single unbounded foot per word, or whether stressless syllables may fall outside a single bounded foot encoding primary stress.

(11) a. stress-accent is obligatory
b. stress-accent is culminative
c. the stress-bearing unit is the syllable
d. the accentual domain is the word
e. stress-accent represents metrical prominence

First, there are languages which satisfy (11a) but not (11b), and vice versa (Hyman 2006, 2009). Second, the obligatory or culminative property in such languages typically involves a fixed H(igh) tone, and possibly nothing else, thereby making it hard to show in some cases that this H is actually a realization of metrical prominence. Third, in some of these languages, the obligatory or culminative H tone is assigned to the mora, while the stress-bearing unit is generally assumed to be the syllable (cf. Hayes 1995: 49). In fact, in such languages, two kinds of 'accent' contrast within a syllable: if the H goes on the first mora, the result will be a [HL] falling tone; if it goes on the second mora, the result will be a [LH] rising tone (which in some languages may be flattened to a phonetic H pitch). As an illustration, consider the following examples from Kinga, a Bantu language in which all words must have a H tone (Schadeberg 1973):

(12)	a.	ʊkóheka	'to laugh'	[H]
		ʊkóvala	'to count'	
		ʊkʊgeendélela	'to walk around'	
	b.	ʊkʊgéenda	'to go'	(HØ → [HL])
	c.	ʊkʊhwaánana	'to become similar'	(ØH → [H:])

In the infinitive a /H/ is assigned to the antepenultimate mora (vowel). This results in a simple [H] in (12a), where the antepenultimate mora also constitutes a short CV syllable. In (12b) and (12c), however, where the /H/ is assigned to the first vs. second mora of a bimoraic CV: syllable, the result is a contour tone. A similar result is found in Somali, where /H/ is culminative, but not obligatory, e.g. most subject nouns and verbs are realized without H: *inan wáa dhaʕay* 'the boy fell' (Hyman 1981; Saeed 1999). While terms such as 'pitch-accent' are often applied in such cases, the larger question is whether obligatory or culminative /H/ tones should be equated with accent. Finally, in some languages the obligatoriness or culminativity is effected not at the word, but rather at the phonological phrase level. This is the situation in Chimwiini, which exhibits both obligatory H and culminative vowel length at the phrase level (cf. (19)–(20) below).

Such problems have led some to distinguish two kinds of WA: stress-accent, which meets the criteria in (7) and (8), and 'pitch-accent', which meets either a subset of the properties of stress-accent or exhibits a set of related properties (cf. Hualde, 2012: 160). One could, for example, stipulate that pitch-accent

refers to a tone that has to be either obligatory or culminative, and whose accent-bearing unit can be either the syllable or the mora. However, as I argue in Hyman (2006, 2009), this would yield a rather loose set of 'pitch-accent' systems, with relatively little in common: obligatory vs. culminative vs. obligatory/culminative, syllable vs. mora, word vs. phrase, etc. The problem gets even worse if we consider other 'evidence' for WA, e.g. designating positions which show greater consonant or vowel contrasts as 'accented' (cf. §2.4 below). It is doubtful that a culminative 'at most one' aspirated or glottalized stop per word can make a language 'accentual'.

The approach that I advocate is what I call 'property-driven typology'. Whereas word-prosodic typology has been concerned with pigeon-holing languages and giving them names such as 'tone', 'stress-accent', and 'pitch-accent' (see Hyman 2009 for a critique of this practice), there are two immediate problems. First, some languages have both tone and stress. Second, there are languages which lie on the border between such claimed 'types' (recall Levi's 2005 decision to call Turkish a "pitch-accent language"). The approach of property-driven typology is to eschew the concern of naming languages or systems and typologize on the basis of the individual properties. We then ask two separate questions: Do the properties of Language X meet the explicit definition, e.g. of stress-accent and/or tone? If so, to what extent do these properties not meet the individual canons?

While *stress-accent* is a coherent notion, namely the prosodic type defined by (7) and (8), the more general concept *word accent* is not – or at least has not been shown to be coherent. Recall from the Kinga examples in (12) that cases where an obligatory and/or culminative /H/ is assigned to a particular mora (rather than syllable) cannot be assumed to represent stress-accent, at least not without changing the syllable requirement in (8). An even more serious challenge to the universality of (8) comes from another aspect of Bella Coola, where, according to Bagemihl (1991), all syllables must contain a vowel or sonorant consonant. However, there are full words and utterances that consist solely of voiceless obstruents, e.g. *xłp'χ^{w}łłpłłs k^{w}c'* 'then he had had in his possession a bunchberry plant' (Nater 1984: 5, cited by Shaw 2002: 119). In addition, Hyman (1985: 26–32) claims that there are no syllables in Gokana at all (cf. Hyman 2011 for an updated statement). If we insist that stress-accent can only be assigned to syllables, and if these studies are correct, then either some words (Bella Coola) or all words (Gokana) can lack stress-accent.

A similar problem would arise in any language which could be demonstrated to lack (phonological) words (cf. Schiering *et al.* 2010), or where stress appears to be phrasal, as often claimed for French. Consider the following variations in word- and phrase-based penultimate stress in Yowlumne (Newman 1944: 28–9; Archangeli 1984–1985: 112):

(13)

a.	[ʔóhom]	[maʔ	ním	hiʔ]	[dab	wíyen]	[mókyi]	‘you, then, will
b.	[ʔohóm	maʔ]	[ním	hiʔ]	[dab	wíyen]	[mókyi]	not tell my
c.	[ʔohóm	maʔ]	[nim	híʔ	dab]	[wíyen]	[mókyi]	wife’
d.	[ʔohom	maʔ	ním	hiʔ]	[dab	wíyen]	[mókyi]	
	not	you	my	will	then	tell.fut	wife	

As Newman (1944: 28) puts it:

(14) A group of words composing a phrase is pronounced as a stress unit, taking the stress on the penultimate syllable. Nouns and verbs tend to keep their word stress unmodified in the phrases, largely by acting as the phrase nucleus in drawing to themselves any preceding unaccented words . . . However, the grouping of words into phrases is extremely plastic . . . In faster speech the phrases tend to be longer and the stresses, as a result, fewer in number.

The multi-word bracketings in (13) are consistent with Bickel *et al.*’s (2009: 64) observation that “stress-related domains tend to be universally larger than other domains”.

One of the claims made by Schiering *et al.* (2010) is that the phonological word may be non-distinct from the phonological phrase in certain ‘monosyllabic’ languages. Their example is Vietnamese. The one we will consider here is Kuki-Thaadow, whose mostly monosyllabic words exhibit the following syllable and tone contrasts:

(15)

		/H/	(→ LH)	/HL/		/L/	
CVV	:	mŭu	‘hawk’	vâa	‘bird’	khàa	‘body lice’
CVD:	:	kăm	‘mouth’	nôw	‘seedling’	mòl	‘stick’
CVVD	:	dăay	‘dew’	kêe	‘leg’	vàan	‘sky’
CVʔ	:	phĕʔ	‘mat’	tsêʔ	‘brick’	vòʔ	‘pig’
CVT	:	–		–		kòt	‘door’
CVVT	:	–		khûup	‘knee’	–	

In the vast majority of cases a Kuki-Thaadow word is monomorphemic and monosyllabic. The shapes of these monosyllables are indicated in the first column of (15), where T = /p, t/; D = /w, y, l, m, n, ŋ/, VV a long vowel or one of the two diphthongs, /ie/ and /uo/. The three underlying tones are /H/, /HL/, and /L/. As indicated, /H/ is realized LH in isolation (Hyman 2010). The question is whether there is evidence that all (or certain) monosyllabic words are stressed.

One possible relevant fact is that a rule of vowel shortening affects /CVV/ words within phrases, e.g. when a noun is followed by a modifier:

(16)

vâa	'bird'	mŭu	'hawk'	khàa	'lice'
vá lìen	'big bird'	mù lîen	'big hawk'	khà lìen	'big lice'
vá thŭm	'three birds'	mú thúm	'three hawks'	khà thŭm	'three lice'
vá ↓thâa	'bird's strength'	mú thâa	'hawk's strength'	khà thâa	'lice's strength'

While I will ultimately reject the following interpretation, someone who is concerned that all languages should have word stress might claim that the phrases in (16) are phonological words with final stress. That is, CVV → CV is a 'reduction' process due to lack of stress on the initial nouns in (16). However, against this interpretation I would present the following arguments:

(i) The derived CV behaves exactly like other syllables. Other than the shortening, there is no segmental or tonal reduction. The tonal alternations on the shortened versions of /vâa/, /múu/, and /khàa/ seen in (16) are exactly the same as those which are found on CVT, CVVT, CVD, and CVVD. This includes the obligatory simplification of contours on all non-final syllables.

(ii) Length is not affected ('reduced') in closed syllables, e.g. *vààn lìen* 'big sky'. The shortening rule is specific to underlying /CVV/, which does not contrast with /CV/.

(iii) Shortening can apply to several CVV words in a row. In the following examples, /hòo/ is a plural marker:

(17)

vâa	+	hlàa	+	gùu	+	hòo	→	vá hlà gù hòo	'bird's wing-bones'
múu	+	lúu	+	khâa	+	hòo	→	mú lú khá hòo	'hawk's head lice'

It would seem counterintuitive to claim that the forms on the right constitute quadrisyllabic phonological words (as opposed to phonological phrases).

(iv) There are some CVV words which fail to shorten because they derive historically from *CVʔ (present-day CVʔ derives from earlier *CV(V)k and *CV(V)r). A minimal pair is shown in (18).

(18)

nàa	+	màn	→	nà màn	'work price'	
nàa	+	màn	→	nàa màn	'leaf price'	(cf. Hakha Lai nǎʔ 'leaf')

It is of course possible to analyze 'work' as /nàa/ and 'leaf' as /nàC/, making it identical with other CVC forms, but why should /CVV/ show a tendency to stresslessness while /CVC/ and /CVVC/ do not? If word stress is obligatory, one would have to say that every non-CV syllable is 'stressed'. At best, this would be redundant.

Two additional problems for the universal WA hypothesis come from Chimwiini (Kisseberth 2009). The first is that the "accentual" criteria do not line up. Chimwiini has two culminative properties: (i) vowel length, which can be realized only on the penultimate or antepenultimate syllable; (ii) H tone,

which can be realized only on the penultimate or final syllable. The two culminative properties produce the four combinations in (19), only one of which shows the two coinciding:

(19)		*antepenultimate V:*		*penultimate V:*	
	final H	na:-ku-já	'you SG. are eating'	ji:lé	'you ate'
	penultimate H	na:-kú-ja	's/he is eating'	jí:le	's/he ate'

The question is: Which of these culminative properties represents the 'accent' that universalists might identify with WA in other languages? While Selkirk (1986) provided a metrical analysis of culminative length similar to the Latin stress rule, the one H is more stress-like in the sense that it is both culminative and obligatory. However, there is another problem in Chimwiini: both properties are culminative (and H is obligatory) at the phonological phrase level. Thus compare the sentences in (19) with those in (20), where /ma-tu:nda/ 'fruit' is underlyingly toneless:

(20)				
	final H	jile ma-tu:ndá	'you SG. ate fruit'	(cf. ji:lé 'you SG. ate')
	penultimate H	jile ma-tú:nda	's/he ate fruit'	(cf. jí:le 's/he ate')

As seen, the underlying length of the first word /ji:le/ is not realized. Second, the final vs. penultimate H of the one-word utterances *ji:lé* 'you ate' and *jí:le* 's/he ate' is not only lost, but the contrast is actually 'transferred' to the following noun object /ma-tu:nda/. It seems that neither of these would-be accentual properties can be equated with WA.

The above discussions of Kuki-Thaadow and Chimwiini examine the 'accentual' potential of vowel length. Vowel length is often cited as evidence for stress-accent in Bantu languages in two situations: (i) languages which have lost the Proto-Bantu vowel length contrast may have penultimate vowel lengthening; (ii) languages which have preserved the contrast may restrict V: to the penult, or to antepenultimate and penultimate positions, as was seen in Chimwiini. However, Bantu penultimate lengthening is a phrasal phenomenon, often intonational, as in Shekgalagari, where lengthening is observed in declaratives, but not in interrogatives, among other utterance-types (Hyman and Monaka 2011: 277):

(21)		*Declarative*		*Interrogative*	
	a.	ri-nâ:rɪ	'buffalos'	ri-nárí	'buffalos?'
	b.	a-bal-a ri-nâ:ri	'he is counting buffalos'	a-bal-a ri-nárí	'is he counting buffalos?'

I know of only one Bantu language where the domain is the word: "Penultimate vowel lengthening. That is a word-level boringly regular phenomenon in Komo" (Paul Thomas, p.c., 2008).

As examples of the second situation, long vowels may be prohibited (and hence shortened) in either pre-penultimate or pre-antepenultimate position, depending on the language (APPL = applicative, CAUS = causative):

(22) a. Pre-penultimate shortening in Cokwe (van den Eynde 1960: 17)
ku-huul-a 'peel off' → ku-hul-il-a 'peel off for' (APPL)

b. Pre-antepenultimate shortening in Lunda (elicited with Boniface Kawasha)
ku-kwáat-a 'to hold, arrest' → ku-kwáát-ish-a → ku-kwát-ish-il-a
HL (CAUS) (CAUS+APPL)

However, such shortening is also typically a property of the phrase, as in Kimatuumbi (Odden 1990: 260, 261):

(23) a. kịkóloombe 'cleaning shell'
kịkólombe chaángu 'my cleaning shell'

b. naa-kálaangịte 'I fried'
naa-kálangịte chóolya 'I fried food'

As seen in 'I fried food', the prefixal part of the verb is not affected by the shortening process, possibly because its length is derived (/ni + a/ → *naa*). The question is whether such phrasal restrictions on length should be identified with stress.

A very interesting variation on vowel length constraints is found in Ngangela:

(24) . . . une voyelle ne peut être longue que si toutes les voyelles qui suivent jusqu'à la pénultième comprise sont également longues. (Maniacky 2002: 20)

As in Cokwe, vowel length is automatically realized in penultimate position. However, unlike Cokwe, Lunda, and Chimwiini, vowel length is not culminative: a pre-penultimate long vowel can surface as long as all vowels that follow it up to and including the penult are also long. Thus consider the following verb forms:

(25)

a.	-teetááŋga	'partager'	cf. -tééta	'couper'
	-teetaaŋgééni	'partagez! (PL.)'		
b.	-vuulwííθa	'rappeler, remémorer'	cf. -vulúka	'se rappeler'
	-taambwííθa	'distribuer'	cf. -tambúla	'recevoir'
	-ʃaambwííθa	'infecter, contaminer'	cf. -ʃambúka	'être contaminé'
c.	-pulááŋga	'couper en tranches'	cf. -púla	'couper au couteau'
	-holwééθa	'refroidir (TR.), calmer'	cf. -holóka	'refroidir (INTR.), se calmer'
	-aʃááŋga	'atteindre plusieurs fois'	cf. -áʃa	'lancer'
d.	ŋgóombe yáaŋge ~ ŋgómbe yáaŋge	'my cow'		

In (25a) not only is the penultimate long, but so are the preceding vowels in each form. The forms in (25b) look rather similar, with the vowel length of the initial syllable being licensed by the long penultimate [íí]. However, note that the vowels are short in the corresponding related forms to the right. It is these that show that the first syllables are underlyingly /vuu/, /taa/, and /ʃaa/, which must be shortened before the short penult in *vulúka*, etc. Not only must the penult be long, but there cannot be an interruption in the chain of long vowels: CVV.CVV.CVV.CV is well-formed, but CVV.CV.CVV.CV is not. (25c) shows that this is not length agreement, as the first syllables remain short before long penultimate vowels. While such licensing of pre-penultimate length appears to be mostly word-bound, (25d) shows that part or more of the noun phrase (and perhaps other constituents) may form 'prosodic groups' in which the first word optionally undergoes shortening. Maniacky (2002: 20) thus observes:

(26) Pour finir, signalons que la perte de longeur vocalique est assez aléatoire au niveau post-lexical. La position pénultième dont on doit tenir compte est celle du mot, et non celle de l'énoncé tout entier. Dans notre étude tonale, nous définirons un groupe prosodique qui correspond au syntagme nominal. Dans ce cas-là, l'abrègement est plus sensible à l'ensemble de l'énoncé, sans vraiment être systématique.

While the (ante-)penultimate length effects definitely indicate that all positions are not treated equally in such languages, two points should be noted. First, different positions may be privileged for tone vs. length. Besides the non-overlap we saw in (19) from Chimwiini, the Nguni languages show penultimate lengthening, but rightward attraction of a H to antepenultimate position. Second, these positions do not usually have segmental effects, whether on the inventory of contrasts or on the phonetic realizations. An exception to this comes from the variety of Makonde described by Liphola (1999, 2001). As seen in the following examples, Makonde has the familiar process of root-controlled vowel height harmony found in many Bantu languages. It also has penultimate lengthening which in the following examples applies to the applicative suffix /-il-/:

(27)

a.	/ku-pelivilil-il-a/	→	ku-pelevelel-eel-a	'to not reach a full size for'
b.	/ku-kolumul-il-a/	→	ku-kolomol-eel-a	'to cough for'

As seen, the triggers of vowel harmony are the root vowels of /pel/ and /kol/. This much is unsurprising. What is unusual, however, is that pre-penultimate mid vowels may optionally 'reduce' to [a]:

(28)

a. 'to not reach a full size for'	b. 'to cough for'	
/ku-pe̱livilil-il-a/	/ku-ko̱lumul-il-a/	
ku-pelevelel-eel-a	ku-kolomol-eel-a	(no vowel reduction)
ku-palevelel-eel-a	ku-kalomol-eel-a	(one application)
ku-palavelel-eel-a	ku-kalamol-eel-a	(two applications)
ku-palavalel-eel-a	ku-kalamal-eel-a	(three applications)
ku-palavalal-eel-a		(four applications)

This apparent reduction process does not require the penultimate vowel to be long (the process applies even when the verb has a short penult in phrase-internal position) or even a mid vowel ([e] and [o] can reduce to [a] even if the penultimate vowel is /a/). There are two facts that point to the penult as a prominent position: First, whether long or short, penult [e] and [o] cannot themselves reduce to [a]. Second, the reduction of pre-penultimate mid vowels to [a] cannot be interrupted by [e] or [o]. Thus, forms such as **ku-palevalel-eel-a* and **ku-kolomal-eel-a* are ungrammatical. What this means is that there is a cline building up to the penult: a vowel further to the left (and hence lower on the cline) cannot fail to reduce if a vowel further to the right (and hence higher on the cline) does not. We now see the relation to Ngangela, where an earlier pre-penultimate vowel cannot be long if a later (penultimate or pre-penultimate) vowel is short. The further a syllable is away from the penult, the more likely it is to undergo vowel shortening in Ngangela and vowel reduction in Makonde.

To summarize the above, we have seen that a number of problems arise in equating the traditional features of pitch (tone) and duration (vowel length) with WA. In the next section I present and ask whether other cases of 'positional prominence' should be interpreted as WA.

2.4 Positional prominence and word accent

The Ngangela and Makonde examples are quite interesting in that there appears to be a gradual cline in prominence up to the penultimate position. If such effects are 'accentual', however, the penult does not seem to have Dresher and Lahiri's (1991) 'metrical coherence'. In most Bantu languages, including Makonde, the root-initial syllable contrasts more vowels than other positions, including the penult (see (31) below). We would like to know not only how widespread such positional prominence effects are cross-linguistically, but also whether they necessarily cohere with WA in a single position.

A limited case of this sort may be provided by Leggbó (Hyman and Udoh 2007). The relevant phenomenon is illustrated in (29).

(29)

a.	CV	du	‘beat’	du-ɛ	‘beat him’	du-ɔ	‘beat you’
b.	CVV	zoo	‘find’	zoo-ɛ	‘find him’	zoo-ɔ	‘find you’
c.	CVC	dum	‘bite’	dum-ɛ	‘bite him’	dum-ɔ	‘bite you’
d.	CVC-i	bini	‘carry’	bini-ɛ	‘carry him’	bini-ɔ	‘carry you’
e.	CVC-a	tùma	‘stop’	tùùm-ɛɛ	‘stop him’	tùùm-ɔɔ	‘stop you’
				/tùma+ɛ/		/tùma+ɔ	

The forms in (29) show how the two pronominal enclitics -ɛ ‘him/her’ and -ɔ ‘you SG.’ are realized after verb stems of different shapes. Everything is straightforward in (29a–d). In (29e), however, we see that the final /a/ of *tùma* ‘stop’ fuses with the enclitics, producing long -ɛɛ and -ɔɔ. This much also is straightforward. What is not expected is that the root vowel also lengthens – and only in this context. While Hyman and Udoh consider various analyses, including an otherwise unattested process of length harmony, given Ngangela and Makonde, this may not seem so far-fetched: a less prominent non-root vowel can be long only if the more prominent root vowel also is. Whereas Ngangela shortens a less prominent long vowel if followed by a more prominent short vowel, Leggbó appears to lengthen the more prominent short vowel to agree with the less prominent long vowel.[6] As Hyman and Udoh lament, Leggbó does not provide appropriate longer stems to test whether lengthening might be iterative. Stems are generally mono- or bisyllabic, and can be trisyllabic only when a verb root occurs with the pluractional suffix *-azi* – which unfortunately does not end in /-a/.

What can be tested, however, is whether the root syllable is in fact prominent in other ways. The table in (30) presents the consonant contrasts in stem-initial, stem-medial, and stem-final position:

(30)

a. *Initial* =38										b. *Medial* = 10			c. *Final* = 4		
p	t	c	k	kp	pp	tt	cc	kk	kkp			kk			
b	d		g	gb	bb	dd	jj	gg	ggb	bb	dd				
					ff	ss									
v	z				vv	ddz									
w	l	y			ww	ll	yy				l			l	
m	n		ŋ		mm	nn	ɲɲ	ŋŋ		m	n	ŋ	m	n	ŋ
										mm	nn	ŋŋ			

As seen, thirty-eight consonants contrast stem-initially vs. ten stem-medially (setting aside a small number of exceptions). Since fortis consonants (indicated

[6] This and the previous examples are reminiscent of other cases where high sonority tends to line up with the head of a stress foot (cf. de Lacy 2004).

as double) cannot occur finally, this leaves only four of the ten medial consonants to appear stem-finally. As in so many languages of the Nigeria–Cameroon border area, Leggbó exhibits a much larger set of contrasts stem-initially than non-stem-initially. The same is true of vowels: /i, e, ɛ, u, o, ɔ, a/ appear in the first stem syllable, long and short; only short /i, u, a/ occur in the second syllable.

The question which naturally arises at this point is whether the Leggbó stem-initial prominence effects should be equated with WA, and similarly concerning the penult in Ngangela and Makonde. While there does not seem to be any problem in doing so in Leggbó, the two Bantu languages bring us to a possible contradiction. On the basis of the following vowel and tone distributions, Bennett (1978: 14–15) argues for stem-initial and final WA in Proto-Bantu:

(31)

prefix V	*first stem V*	*internal Vs*	*final stem V*
*i	*i *u	*i	*i *u
*ɪ *ʊ	*ɪ *ʊ	*ɪ *ʊ	*ɪ *ʊ
	*ɛ *ɔ		*ɛ *ɔ
*a	*a	*a	*a
*L	*H, *L	*L	*H, *L

By inheritance, many present Bantu languages maintain fuller vowel and tone contrasts stem-initially, but have subsequently introduced penultimate lengthening. This includes Shona, the language on which Beckman (1997) originally based her model of stem-initial positional faithfulness, as well as Tswana:

(32) When an utterance [in Shona] consists of several phonological words, the final word of the utterance, which may be followed by a pause, carries a marker of penultimate length relatively longer than those of preceding vowels. *ú:ya* 'come', *ú·ya kú:nó* 'come here!', *ú·ya kú·nó, mwà:ná* 'come here, child!', *ú·ya kú·nó mwànáːŋgù* 'come here, my child!' (Fortune 1980: 1.36)

Full length [in Tswana] occurs in the penultimate syllable of a word pronounced in isolation or at the end of a sentence . . . This constitutes the characteristic penultimate accent of Tswana . . . When a word is in non-final sentence position, it still retains its penultimate accent, but in much lesser degree, i.e. only half-length is used. Normal short length occurs in final and non-penultimate syllables, and in some monosyllabic words. (Cole 1955: 55)

How should WA be characterized in such languages? Stem-initial? Penultimate? One primary, one secondary? One word-level, one phrase-level? Once again, as in the case of Chimwiini tone vs. vowel length, the criteria do not line up – and both are assigned exactly within the same phonological phrase domain

(Kisseberth 2009). The 'accents' of Chimwiini are not only phrasal, but also lack metrical coherence.

Despite the fact that most current-day Bantu languages maintain at least some of the Proto-Bantu distributional asymmetries in (31), descriptive statements about stress placement in Bantu are largely geographical: stem-initial stress has mostly been posited for Northwest Bantu languages, e.g. Duala, Kukuya, Bobangi, Ntomba, Bolia, Tetela, while claims of penultimate stress mostly concern Eastern and Southern Bantu, e.g. Kinande, Chichewa, Shona, Xhosa. Many descriptions of Bantu languages fail to mention stress, or claim there is no stress. Besides Luganda in Eastern Bantu, consider the more westerly Lomongo and Ngombe:

(33) . . . l'accent dynamique [in Lomongo] est entièrement éclipsé par la marcation bien plus essentielle des tons. (Hulstaert 1934: 79)

. . . even [those Ngombe speakers] who readily recognize the position of tone in the words of their own language, find it difficult to decide where the stress of a given word lies. (Price 1944: 28)

To this we can add that Hulstaert (1961: 129) ran experiments showing that there is no stem-initial stress in Lomongo, which is, however, a Northwest Bantu language.

2.5 Systems with tone and word accent

The above characterization of Ngombe speakers brings us back to formal vs. phonetic approaches to stress: the formal (metrical) approach insists that stress-accent is abstract and not necessarily detectable in terms of consistent phonetic features. As Lehiste (1970: 150) put it several decades ago:

(34) It appears probable that word-level stress is in a very real sense an abstract quality: a potential for being stressed. Word-level stress is the capacity of a syllable within a word to receive sentence stress [read: a 'pitch-accent'] when the word is realized as part of the sentence.

Of course certain phonetic properties tend to accompany stress, e.g. effects on consonants and vowels. A curious reversal of strategy is to go directly from these expected phonetic properties to claims about stress: many descriptions of stress are impressionistic, with possible interference from English or other languages. The logical extreme of this occurs when the realizational features of stress are exploited for distinctive purposes, e.g. intensity:

(35) . . . stress in Nilotic is privative, a feature with binary opposition . . . a word may be stressed or not. The stress in itself may function as a morpheme in some cases and stress may occur on any of the three level tones. (Gilley 2004: 100)

Shilluk examples of alleged distinctive stress are cited in (36).

(36)

	Singular	*Plural*			*Singular*	*Plural*	
a.	ˈdít	diɛ̂t	'bird'	b.	álàʈ̪	áˈlɛ̀ʈ̪	'cloth'
	ˈʈ̪òok	ʈ̪óòk	'mouth'		pɛ́ɛ̀m	ˈpɛ̀ɛ́m	'chest'

Gilley (2004: 117) describes the phonetics of distinctive stress as follows:

(37) Phonetically, stress in these Nilotic languages is characterized by a shortening of vowel length, and by an increased intensity or level of force on the syllable.

The problem is that this interpretation leaves Shilluk with many unstressed words, in contradiction to the definition of stress-accent in (7).

It is occasionally remarked that pitch and duration may be more restricted or less likely cues for WA in languages with contrastive tone and length, respectively (cf. Wetzels 2002: 627). Stress is often elusive and is usually assumed to be absent in West African languages with tone, e.g. in Igbo, Yoruba, Nupe, Ewe, Akan.[7] However, Africanists do appreciate that a language can have tone and stress. Besides the kind of segmental asymmetries seen above in Leggbo, tonal distributions and realizations may also be sensitive to root–affix distinctions. Thus, Noonan (1992: 42) describes Lango, another Nilotic language, with root-initial WA:

(38) Primary stress in Lango is invariably placed on the root syllable . . . Where the root is longer than one syllable – only possible in nouns – the first vowel receives stress . . . Stressed vowels in Lango are somewhat louder and slightly longer than unstressed vowels. The difference between stressed and unstressed vowels is not as pronounced as in English; instead, the relation between them is closer to that found in syllable timed languages such as Spanish.

As evidence that stress is playing an active role in the phonology, Noonan describes the following stress-sensitive tone rule:

(39) Following a H, L's become H's up to and including the next stressed L, or until a H is encountered, the last L to be affected becoming HL. The rule may apply across word boundaries. (p. 51)

Examples of the operation of this rule are seen in (40).

(40)

a.	/ˈdɔ́g ˈgwɛ̀nò/	→ dɔ́g gwɛ́nò	'a chicken's mouth'	('mouth' + 'chicken')
b.	/ˈpíg àˈbòlò/	→ píg ábólò	'plantain juice'	('juice' + 'plantain')

[7] Russell Schuh (p.c. 2010) confirms that he has never seen any need to posit word stress in Chadic languages, all of which are tonal. This is not to say that foot structure is irrelevant for other purposes, e.g. tone or even vowel harmony (cf. Leben 1996; Pearce 2006, 2007).

In all of the above I have been assuming that stress-accent is a type of WA, the latter being perhaps more permissive. One issue that was addressed with respect to Kinga in (12) is that a language may assign an obligatory and culminative /H/ to moras rather than to syllables. In Kinga a word must have a H on either the antepenultimate, penultimate, or pre-stem mora (Schadeberg 1973: 23). What this means is that there will be exactly one H tone per word, as in the case of primary stress-accent. Contrast this with Somali, where the /H/ which can be assigned to either the penultimate or final mora is culminative ('at most one') but not obligatory ('at least one'). Thus, in the sentence *inan wáa dhaʕay* 'the boy fell', neither the subject noun *inan* nor the verb *dhaʕay* has a H tone (*wáa* is an inflectional particle). Since many words will be toneless, one cannot know how many words there are by the number of H tones, i.e. the biuniqueness test referred to above fails. This raises the question of how functional culminative, but non-obligatory, H or HL tone is in languages like Somali and Tokyo Japanese.

The same question arises in systems where /H/ is obligatory, but not culminative. As a case in point Michael (2011: 62) analyzes Iquito with both metrical structure and an obligatory but non-culminative H:

(41) All prosodic words in Iquito bear at least a single H tone, and if a given prosodic word lacks lexically specified high tones (a common occurrence), a high tone is assigned to the syllable bearing primary stress [= the penultimate mora].

The examples in (42) illustrate a minimal pair between lexical and default H tone:

(42)

					-ya 'plural'	*kí- 'my'*
a. lexical initial H	:	/túuku/	túuku	'tumpline'	túuku-ya	kí-túuku
b. default penult H	:	/tuuku/	tuúku	'ear'	tuukú-ya	kí-tuuku

In (42a) there is a lexical /H/ on the first mora of /túuku/ 'tumpline' which remains in place when followed by the toneless suffix *-ya*. When preceded by the H tone prefix *kí-*, two H tones are observed in the word 'my tumpline', showing that H tone is not culminative in Iquito. In (42b), the toneless word /tuuku/ 'ear' receives a H on its penult in isolation, but on its final mora when suffixed by *-ya*. Since there is already a /H/ on the prefix of *kí-tuuku* 'my ear', a default H is not assigned. As shown in (43) Michael proposes a right-to-left construction of bimoraic trochees. As expected, default H is assigned in (43a, b), but not in (43c). (43d, e), however, show that default H will be blocked only if a lexical /H/ occurs in the last four moras (two feet forming a colon) of the word:

(43)

a. /pirusu/	→	(pi)(rúsu)	'electric eel'	(moraic trochees)
b. /pirusu-ka/	→	(piru)(súka)	'electric eels'	
c. /kí-pirusu/	→	(kípi)(rusu)	'my electric eel'	(no penultimate H)
d. /kí-pirusu-ka/	→	kí(piru)(súka)	'my electric eels'	
e. /kí-pirusu-ka-hata/	→	kí(piru)(suka)(háta)	'with my electric eels'	

In other words, H is obligatory (but not culminative) within the last four moras of the word.

As summarized in (44), a privative H tone can be obligatory, culminative, both, or neither:

(44)

	Culminative	*Non-culminative*
Obligatory	Kinga	Iquito
Non-obligatory	Somali	Haya

(44) thus demonstrates that obligatory and/or culminative H tone by itself may not be stress-accent. The question is whether it should be identified as some other kind of accent, e.g. 'pitch-accent'. Such a decision comes with baggage. As Gussenhoven (2004: 42) points out:

(45) 'Accent' . . . is an analytical notion and cannot be measured. [It is] thus different from stress, which is typically an observable phenomenon, and different also from tone, whose existence is equally measurable . . .

We thus note the following: while some languages must be analyzed with stress, others with tone, and some with both, no language MUST be analyzed as a third prosodic type called 'pitch-accent'. A tonal interpretation is always possible. In some cases, a so-called 'pitch-accent' language has both stress and tone; in other cases, its tones are simply restricted, e.g. obligatory, as in Iquito, or culminative, as in Somali.

An additional reason to reject the identification of restricted-tone systems with 'accent' is that tone can do things that stress-accent cannot. As an example, consider Urarina (Olawsky 2006: 127–8), whose words generally have a single final H in isolation, but belong to the four classes in (46).

(46)

Class	*Tone pattern determined by A–D class of the phrase-initial word*
A	first word = L; H is assigned to initial syllable of following word
B	first word = L; H is assigned to third syllable of following word
C	first word = L; H is assigned to last syllable of final word of phrase
D	first word keeps its final H tone when a word follows, all the rest = L

Examples are given in (47).

(47)	A	raaná	'peccary (species)'	→	raana rɯ́.a.kaa	'he has carried the white-lipped peccary'
	B	obaná	'peccary (species)'	→	obana rɯ.a.káa	'he has carried the collared peccary'
	C	reemaé	'dog'	→	reemae rɯ.a.kaá	'he has carried the dog'
	D	makusajarí	'pepper'	→	makusajarí rɯ.a.kaa'	'he has carried the pepper'

The important point is that stress systems do not have the property of the restricted /H/ in Urarina: no language has a set of four classes of word which correspondingly assign different stress patterns to the following word. This is something which tones do! Again note from the examples in (47) that H is obligatory only at the phrase level in Urarina, which is also not an expected property of stress systems.

Since tones may be assigned by metrical principles, let us briefly consider the issue of when metricality should be equated with stress. As was pointed out early in its development, the functions of Metrical Phonology can be to count and locate positions or to construct constituents. When performing the latter, there can again be two separate functions:

(48) The construction of bounded metrical constituents performs two separate functions. On the one hand, it subdivides the string into substrings of two (resp. three) elements each; on the other hand, it marks a particular element in the substring as its head by assigning it an asterisk that is then interpreted as stress. (Halle and Vergnaud 1987: 58)

What makes the head-marking so convincing in a stress-accent language is the globality factor: headed, i.e. stressed, syllables can have multiple effects throughout a system, as outlined in (5) above. Where metrical tools are needed to locate or place H tones, this globality is typically absent. As a result, it is totally adequate to characterize such cases as "restricted tone systems" (Voorhoeve 1973). Their metricality may be reminiscent of stress-accent, but everything else is like a tone system.

2.5 Conclusion

In the preceding sections we defined stress-accent as a word-level metrical structure identifying one obligatory and culminative head syllable per lexical word. Among the problems addressed were that some languages may have words without syllables or maybe no syllables at all, while other languages assign metrical structure at the phrase level. A property-driven typology will of course ask what the relevant feature-bearing unit is, in what domain the generalizations hold, and so forth. However, since the possibilities are numerous

and sometimes contradictory, it makes little sense to invoke a third category of 'pitch-accent'. Even as a practical label, it tells us little: we need to know the specific properties.

To determine the relevant properties, I have invoked Clements's notion of phonological activation in (6). Languages may 'care' a lot about stress in the sense of multiple activation, or relatively little, perhaps not at all. As a comparison, consider nasality: while some languages care a great deal about the feature [nasal], allowing it to characterize not only consonants but also vowels, making it into a prosody or harmony, nasality is more restricted in most languages (e.g. as a segmental feature on consonants), or even absent entirely (e.g. in several Lakes Plain languages of New Guinea). And so it is with stress. A language without stress would be one in which syllables are undifferentiated from each other, showing none of the classical signs of stress. If such a language makes it so hard to find the stress, one naturally has to ask whether stress is phonologically activated at all. The English system in (5) presents a stress system at one end of the spectrum. Toward the other end of the spectrum, recent psycholinguistic work has found that speakers of languages with only slight marking of stress may exhibit "stress-deafness" (Peperkamp and Dupoux 2002), e.g. French, Hungarian, and Finnish vs. English and Polish. The logical end point is languages without convincing word-level stress at all. This last possibility will not be welcome by all. Goedemans and van der Hulst (2009: 238), for instance, would like to include stress under a broader, universal notion of 'accent':

(49) A comprehensive typology of accent manifestation remains to be developed, but given the broad area of cues and functions it is likely that many more languages may have word accent than just those in which accent is manifested as 'pitch' or 'stress'. As a working hypothesis, we might assume that all languages have accent.

Although considering the notion of 'accent' to represent a spectrum of properties is very appealing, it will be useful only to the extent that we are clear as to what counts as accent and what does not. As we have seen in several cases, a language may have two (more?) accentual properties which conflict, e.g. by picking out different positions to mark as 'heads' for vowel length vs. tone. While one may intuit that all of the above is accentual, there seems to be little advantage in doing so.

This leads us to the following final question which I also raised in Hyman (2011): What is so great about being universal? Why does it matter? If no language can exist without word stress, one might want to make cognitive claims, but even if only MOST languages have word stress, would we not have to ask the same question of why? Would it change the goals of StressTyp, for instance? Even if universality would mean that stress-accent is 'innate' and

widespread frequency would mean 'highly unmarked', phonologists would still be left with the task of sorting out the tremendous complexities and variations in all systems that have ever been called "accentual' (see especially van der Hulst *et al.* 2010). It seems reasonable at this stage of the enterprise to suggest a shift: rather than focusing on universality (and innateness), the real issue, following Evans and Levinson (2009), is to map out and address the extraordinary diversity found in prosodic systems and in phonology in general. Only then will we have a full picture of what is possible in human language.

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3 Disentangling stress and pitch-accent: a typology of prominence at different prosodic levels

Matthew Gordon

3.1 Introduction

There are numerous studies devoted to the typological examination of stress (e.g. Hyman 1977; Liberman and Prince 1977; Hayes 1980, 1995; Prince 1983; Halle and Vergnaud 1987; Goedemans *et al.* 1996; Elenbaas and Kager 1999; Gordon 2002; Hyde 2002; Heinz 2009; van der Hulst and Goedemans 2009; van der Hulst *et al.* 2010).[1] This research program has produced many interesting observations and theoretical treatments of stress. Nevertheless, despite the advances it has made, stress typology is subject to limitations that make its findings difficult to situate within a broader theory of linguistic prominence encompassing intonation and prosodic constituency. In particular, even early stress typologists (e.g. Hyman 1977) observed that most typological and theoretical work on stress is based on descriptions gleaned from grammars, for which it is plausible, even likely, that the reported stress patterns are based on words uttered in isolation, where the word is equivalent to an utterance. In such cases, the reported stress patterns more accurately reflect phrase- or utterance-level prominence rather than true word-level stress.

This chapter represents a preliminary attempt to tease apart word-level stress from prominence associated with larger prosodic units, with an eye toward creating a typological database of both types of prominence and their relationship to each other. In particular, we focus here on the ability of peripheral syllables to bear prominence at both the word and phrase level.

While this endeavor might seem premature due to the relative paucity of thorough descriptions that disambiguate prominence attributed to different constituents, there is a clear trend toward increasing awareness among linguists of the important distinction between word-level stress and higher-level

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prominence. Grammars are thus more likely nowadays to provide explicit, even if cursory, statements about whether their description of prominence refers to word-level stress or phrase-level prominence. Genetti's (2007) grammar of the Tibeto-Burman language Dolakha Newar provides an example of a recent grammar with a detailed prosodic description featuring a five-page description of stress and a twenty-two-page chapter on prosody, including phrasal accent and intonation, as well as several representative pitch and intensity traces.

Closely intertwined with this movement toward greater clarity of prosodic descriptions is the now ubiquitous availability of free acoustic analysis software, in particular, Praat (Boersma and Weenink 2010), which allows for both rapid confirmation of impressionistic judgments about stress and phrasal prominence and the possibility of more systematic quantitative study of acoustic correlates of prominence of different types. Some grammars now include representative displays such as pitch traces, waveforms, and intensity curves, which provide some sense of how prominence is acoustically manifested. The incorporation of phonetic data of this sort is invaluable in assessing the relationship between word-level stress and phrase-level prominence, which are often distinguished through different phonetic means.

Given the tendency toward greater explicitness of stress descriptions and the buttressing of these accounts with phonetic data, it seems worthwhile to foster this line of research by providing a typological framework into which languages can be categorized according to their prominence patterns associated with different prosodic units, much like languages are commonly classified as being either stress, tone, or pitch-accent languages (see Hyman 2006, this volume, and van der Hulst 2011 for discussion). A further benefit of developing a typology of prominence at different levels is its potential for enriching the phonological literature on metrical stress theory. An enlarged typological database on both stress and phrasal prominence and the interaction between the two will enable linguists to develop richer and empirically more explicit theories of prominence, thereby extending in new directions the research program of metrical stress theory that has been so productive since the 1970s.

3.2 Word-level stress vs. phrase-level pitch-accent

A necessary precursor to discovering generalizations about prominence at different levels is an understanding of the various sources of prominence. Languages are characteristically bifurcated into two groups based on whether differences in prominence are based on lexical contrasts in pitch or not. Members of the former class of languages are traditionally termed 'tone' languages, whereas members of the latter camp are regarded as 'stress' languages. In reality, not all languages can be neatly classed into either the tone or stress

categories (see Hyman 2006, this volume, for discussion), prompting many researchers to introduce a new hybrid type of system based on 'pitch-accent' (see van der Hulst 2011 on pitch-accent). We can abstract away from this complication for the time being, though, and instead confine our discussion largely to more prototypical stress systems, although section 3.4 will delve into some languages instantiating features of lexical tone.

The seminal research on the phonetic correlates of stress conducted by Fry (1955, 1958) identified several acoustic cues to stress, including increased duration and intensity and certain pitch properties such as higher or changing fundamental frequency (F0). Fry (1958) found that, of these features associated with stress, higher F0 was perceptually most important in determining perceived prominence. Acoustic studies of stress have been conducted for many languages since Fry's study, e.g. Polish (Jassem *et al.* 1968), Mari (Baitschura 1976), Indonesian (Adisasmito-Smith and Cohn 1996), Tagalog (Gonzalez 1970), Thai (Potisuk *et al.* 1996), Pirahã (Everett 1998), Aleut (Taff *et al.* 2001), Chickasaw (Gordon 2004), Turkish (Levi 2005), Kabardian (Gordon and Applebaum 2010), with most languages showing a reliance on some combination of increased duration, greater intensity, and/or higher F0 as acoustic markers of stress.

A major limitation of Fry's study (and many like it), however, is that it was based on words occurring in the focal position of an utterance, a position that subsequent work has shown conflates both word-level stress and phrase-level prominence. More recent work (e.g. Sluijter 1995, Sluijter and van Heuven 1996a, 1996b) has attempted to tease apart these two types of prominence, showing that each is realized through different phonetic means and is governed by different prosodic considerations. One of the most important findings emerging from this research is that salient F0 characteristics contributing to perceived prominence are primarily associated with syllables carrying phrasal prominence, often termed 'pitch-accented' syllables (where 'pitch-accent' is used in a different sense from its use to refer to hybrid prosodic systems sharing some features with tone languages and others with stress languages.) A pitch-accent as it pertains to stress languages like English may be broadly defined as a tonal prominence distinct from tones associated with the boundaries of intonational constituents. Pitch-accents characteristically impart semantic information such as focus or other pragmatic content that the speaker wishes to convey. A syllable that carries stress at the word level thus may be promoted to pitch-accent status by virtue of being in a certain position in a phrase or being associated with special semantic or pragmatic focus. For example, in the English sentence *Alligators terrify elephants* it is possible for the first syllable in either *alligators* or *elephants* to bear a prominent pitch-accent depending on which noun is the object of focus. It is also possible for the verb *terrify* to carry a pitch-accent if the sentence is uttered in response to the question *What do*

alligators do to elephants? In case of no special focus on either of the nouns, for example, if answering the question *What do alligators do?*, the first syllable of *elephants* is likely to carry a pitch-accent. It is also possible for there to be multiple pitch-accents in an utterance, as in the response to the question *Who terrifies whom?,* which is likely to have a pitch-accent on both *alligators* and *elephants*.

A consistent feature of most stress languages is that the pitch-accent is restricted to stressed syllables. Thus, only the first syllable of each of the English words *alligators*, *terrify*, and *elephants* is eligible to receive a pitch-accent since the first syllable carries the main stress of each word. This property illustrates an important feature of pitch-accents in most languages (with the exception of the 'top-down' accentual systems discussed in section 3.4.1.2): they are assigned in bottom-up fashion by promoting one of the primary word-level stresses to pitch-accent status.

Another key feature of pitch-accents is that they are, as the name suggests, definitionally associated with certain pitch properties phonetically. This contrasts with stresses assigned at the word level which are not necessarily, in fact often are not, cued by pitch features, but rather by other properties such as increased duration, greater intensity (particularly at higher frequencies), and/or hyperarticulation. Thus, Sluijter and van Heuven (1996a) show that pitch in English is a marker of phrase-level pitch-accent rather than word-level stress, which is instead cued by other properties such as differences in spectral tilt and vowel reduction. Sluijter and van Heuven (1996b) show that spectral tilt is also a marker of stress in Dutch. Similarly, Gordon (2004) finds that, although raised F0 is a useful cue to distinguishing primary word-level stress in Chickasaw, it is subordinate to duration and intensity in its robustness as a marker of word-level stress. At the phrase level, on the other hand, F0 is the most salient signal of pitch-accents.

Pitch-accents are not universally found in all stress languages. Wolof (Ka 1988; Rialland and Robert 2001) and Kuot (Lindström and Remijsen 2005) both have word-level stress, lexically contrastive in Kuot and phonologically predictable in Wolof, but lack phrase-level pitch-accents on stressed syllables. In both Wolof and Kuot, stress is cued by properties other than F0, which is reserved for signaling semantic and pragmatic functions at phrase edges.

3.3 Pitch prominence beyond pitch-accent

Pitch-accents are not the only source of prominence. Pitch excursions associated with phrase edges, especially the right edge, provide another source of pitch movements that potentially contribute to perceived prominence. Most languages realize their unmarked declarative utterances with a terminal pitch fall

(Ladd 1996; Gussenhoven 2004). Depending on the language, other semantic types of utterance may be associated with a pitch fall as well or may be realized with a pitch rise or a combination of the two. For example, *yes/no* questions in English characteristically are realized with a final rise in pitch, thereby distinguishing them intonationally from declaratives and *wh*-questions. The large prosodic units characterizing coherent semantic constituents such as declaratives and questions are typically termed 'Intonational Phrases' or 'Intonation Units'.

Pitch excursions associated with a phrase edge may also be attributed to prosodic phrases smaller than the Intonational Phrase (or Unit). Thus, smaller phrases, termed 'Accentual Phrases', in French (Jun and Fougeron 1995, 2000) are associated with a tonal pattern that includes a final transition from a low-pitch target to a high tone. Similarly, Accentual Phrases in Korean (Jun 1993) are realized with a beginning transition from low to high pitch.

It is significant for the typology of stress that the pitch excursions associated with both Intonational Phrases and smaller phrases may be interpreted as word-level stress for words uttered in isolation, where the word is equivalent to a phrase. Thus, the stress referred to in Fry's work on English is actually attributed to the combination of pitch-accent and terminal pitch excursion characteristic of words uttered in isolation, where the word is equivalent to an Intonational Phrase. Jun and Fougeron (1995, 2000) analyze the prominence on final syllables that is often referred to as 'stress' in French as the pitch rise associated with the right edge of the Accentual Phrase, a smaller phrase than the Intonational Phrase. Similarly, Jun (1995) shows that the percept of stress in Korean is attributed to the pitch rise found at the left edge of an Accentual Phrase.

Perhaps the most striking case of a language that has frequently been analyzed as having word-level stress but has been experimentally shown to possess only boundary pitch excursions is Indonesian. Many accounts of Indonesian posit stress on the penultimate syllable of a word with, in some analyses, a provision that schwa in the penult relinquishes stress to the final syllable (see van Zanten and van Heuven 1998 for an overview). Van Zanten and van Heuven (1998) show, however, that Indonesian listeners fare no better in word recognition gating experiments when presented with a stressed syllable than when hearing an unstressed syllable. Based on this result, they conclude that stress plays no essential communicative function for Indonesian speakers. In another perception experiment, van Zanten *et al.* (2003) found that there is no consistent syllable that is judged by listeners (except those who speak a substrate language such as Toba Batak with contrastive stress) to sound more felicitous when associated with prominence. They conclude (p. 172): "In our view, the rule that drives prominence patterns in the influential Javanese variety of Indonesian is phrasal. Possibly the only phonological rule that is relevant for

accent location in Indonesian states that it must occur somewhere at the right edge of the phrase."

The upshot of this discussion is that it is important to distinguish word-level stress from pitch properties characteristic of units larger than a word. In practice, a study of word-level stress must thus look at words that are not pitch-accented and not found in phrasal positions where boundary excursions might give the erroneous impression of stress.

3.4 The relationship between pitch-accent and word-level stress

Although it is important to distinguish between word-level stress and phrasal pitch properties, there is a close relationship between stress and at least one phrasal pitch feature: pitch-accents. As we have seen in section 3.2, pitch-accents are characteristically assigned in bottom-up fashion based on word-level stress patterns. Thus, only syllables that are stressed at the word level may carry a pitch-accent under normal circumstances in most languages. For example, only the first syllable of *rabbits* or the last syllable of *giraffes* may receive a pitch-accent in the sentence *Rabbits like giraffes*, since they are the only stressed syllables in these words. Likewise, only the first and third syllables of *Tennessee* are eligible for pitch-accents due to their stress. Most commonly, the third syllable of *Tennessee* would serve as the docking site for a pitch-accent associated with the word since it is the primary stressed syllable. However, even a syllable carrying secondary stress could preferentially receive a pitch-accent in certain phrasal contexts. For example, the rhythm rule of English (Hayes 1984) could trigger retraction of the pitch-accent in *Tennessee* to the secondary stressed initial syllable in the phrase *Tennessee governor* in order to avoid a clash with the primary stress on the initial syllable of *governor*.

Most languages typically only promote a subset of word stresses to pitch-accent status. The dominant cross-linguistic pattern is for the primary stressed syllable in the rightmost content word to bear a pitch-accent if there is only one in the phrase, or to bear the most prominent pitch-accent if there is more than one (Ladd 1996). Languages differ, however, in the density of their pitch-accents. An extreme case of pitch-accent density is found in Egyptian Arabic (Hellmuth 2006, 2007), in which every content word is associated with a pitch-accent, which docks on the second mora of the foot containing the primary stress, i.e. on the second half of a stressed long vowel or the coda consonant of a stressed closed syllable, otherwise after a stressed short vowel in an open syllable.

Not all languages behave like English or Egyptian Arabic in having a default rule promoting the primary stressed syllable of a word to pitch-accent status. There are other languages that have 'top-down' pitch-accent systems in which pitch-accents are not necessarily projected from word-level stress but rather

may be assigned based on at least partially orthogonal principles. Thus, several Northern Iroquoian languages (Chafe 1977; Michelson 1988) display an asymmetry between phrase-final words and phrase non-final words in their stress patterns. I mention some of these asymmetries here and refer the reader to Chafe (1970, 1977) and Michelson (1988) for discussion of the many interesting prosodic differences between utterance-final and utterance-medial forms observed in the family. Onondaga draws a distinction between what Chafe (1970) terms 'sentence-final' words and non-sentence-final words in the location of their accent, which is most saliently associated with raised F0. Onondaga words are accented on their final syllable when they are followed by one or more words within a sentence, which he describes as a 'phrasal prosodic constituent'. Words in final position of a sentence, on the other hand, are characteristically accented on the penult, though certain morphemes can trigger either final or antepenult accent. Similar non-finality effects at the phrase level are also observed in related Seneca (Chafe 1977) and Cayuga (Foster 1982; Chafe 1977; Michelson 1988; Dyck 2009), both of which display an alternating stress pattern originating at the beginning of the word from which the phrase-final accent is projected.

One issue that is less clear from published descriptions is the presence and relative prominence of non-final stresses in phrase-medial words. In her analysis of Cayuga, Dyck (2009) marks only the final stress in phrase-medial words. Michelson (1988: 80), on the other hand, following Foster (1980), treats the stresses found in phrase-final forms as also being present phrase-medially in Cayuga. Chafe's (1970) description of Onondaga suggests that only the final syllable is stressed in phrase-medial words. In Seneca, on the other hand, any accents found in phrase-final words are also present in phrase-medial words in addition to the word-final accent, although the relative prominence of the different accents is unclear (Chafe p.c.). Assuming that the non-final stresses are at least present (regardless of their prominence relative to the final stress) in phrase-medial forms, the pitch-accent in phrase-final forms in Seneca and Cayuga selects a syllable that already has some degree of stress at the word level. In Onondaga, on the other hand, the accent in phrase-final words appears to be docking on a syllable that is unstressed phrase-medially.

Another case of an accent falling on a syllable that is unstressed at the word level is found in the Muskogean language Chickasaw (Gordon 2003). Thus, words that have word-level stress on a final light (CV(C)) syllable position the pitch-accent on a non-final syllable in questions. Thus, the word *tiʃo* 'helper to a medicine man' has final stress in non-final position of a phrase, e.g. *tiˈʃo pisa* 's/he looks at the helper to a medicine man', but at the end of a question it has the pitch-accent on the penult, e.g. *kataːt tíʃo?* 'Who is a helper to a medicine man?'. The English equivalent to this type of pattern would be exemplified by the highly unnatural-sounding rendition of the question *What is a gíraffe?*

with a pitch-accent on the first and unstressed syllable of *giraffe* rather than the second and stressed syllable.

Chickasaw and the Northern Iroquoian languages mentioned above share certain interesting properties. In both languages, the pitch-accent is more resistant than stress to docking on final syllables. This non-finality effect observed in pitch-accent placement is common in languages with top-down pitch-accent systems and is examined further in section 3.4.1.2.

It is also interesting to note that the final stress in Chickasaw, Seneca, and Cayuga is also completely independent of the rhythmic stress that initiates at the opposite edge of the word, creating a stress clash at the right edge of words in which the penult is in a metrically strong position as calculated from the beginning of the word. Chickasaw, Seneca, and Cayuga thus represent a case of non-metrical primary stress (van der Hulst 1984, 1997, this volume, chapter 11), i.e. the primary stress being positioned independently of rhythmic stress.

There is another interesting feature of Chickasaw. There is phonetic evidence that the primary stress in a word bearing a pitch-accent winds up on the same syllable as the pitch-accent. Thus, pitch-accented syllables not only are associated with higher F0 than other unaccented syllables, but they also are realized with other phonetic correlates of primary stress, including increased duration and intensity relative to both unstressed and secondary stressed syllables (Gordon 2003). Although one could argue that duration and intensity are parasitically increased due to the pitch-accent rather than reflecting stress in its own right, it is empirically simpler to assume that both primary stress and the pitch-accent congregate on the same syllable than to assume that they dock on different syllables. Furthermore, it is also not a logical necessity for pitch-accented syllables to also be associated with increased duration and intensity as the separation of tone and stress in many languages, both those with lexical tone, e.g. Pirahã (Everett 1998) and Thai (Potisuk *et al.* 1996), and those with intonational boundary tones, e.g. Wolof (Rialland and Robert 2001) and Kuot (Lindström and Remijsen 2005), demonstrates. The tendency for stress and pitch-accent to end up on the same syllable regardless of the direction of attraction appears to be a shared characteristic of stress languages. Consistent with this view is the fact that normally unstressed syllables in English wind up with all the stress-related properties when they carry a pitch-accent to mark contrastive syllable-level focus (van Heuven 1994), e.g. *I said sum*MA*ry not sum*ME*ry*.

There are, however, certain exceptional cases of intonational tones that are attributed neither to prosodic boundaries nor to pitch-accents. Papiamentu (Remijsen and van Heuven 2005) and many varieties of Swedish and Norwegian (Riad 2006) possess a different type of tonal accent, termed a 'prominence

tone' by Riad, that may not be projected from word-level stress but is also not associated with a boundary. The distinction between the prominence tone and both boundaries and stress can be observed most clearly in polysyllabic words containing multiple stresses. According to Riad's (2006) analysis, in certain Scandinavian dialects, e.g. Central Swedish, the prominence tone docks on the stressed syllable, typically the rightmost one, which is a secondary stress in words with multiple stresses. In other varieties, such as Southwestern Norwegian, the prominence tone associates with the post-tonic syllable rather than the secondary stressed syllable. In both varieties, the left edge of the word is associated with a high tone and the right edge with a low tone, though these boundary tones are not found in all contexts (Bruce 2005). This contrast between dialects is illustrated by the word *sommarledigheten* 'the summer vacation', which is realized in Central Swedish as in (1a), and in Southwestern Norwegian as in (1b), where the prominence tone in both dialects (but not in all Scandinavian varieties) is LH (adapted from Riad 2006: 44).

(1) Tonal association in two varieties of Scandinavian (based on Riad 2006)

a. Central Swedish

```
H            LH   L
|              |  |
ˈsommarˌledigˌheten
```

b. Southwestern Norwegian

```
H   LH           L
|   |            |
ˈsommarˌledigˌheten
```

Papiamentu (Remijsen and van Heuven 2005) also has a LH prominence tone that docks on an unstressed final syllable under focus in a certain class of words with stress on the penultimate syllable. In another class of words, the prominence tone aligns with a stressed syllable, either the penult or the ultima depending on a word's tonal category.

One complication concerning the Scandinavian and potentially the Papiamentu cases is the possibility of alternative analyses that attribute the prominence tone to a bitonal pitch-accent containing a leading or trailing tone that phonetically either precedes or follows, respectively, the syllable with which it is phonologically associated (see, for example, Bruce 2005 on Swedish).

A clearer case of a prominence tone that is not projected from stress and is not amenable to reanalysis as a bitonal pitch-accent is found in Nubi (Gussenhoven 2006). Every Nubi word contains one high tone, whose location is lexically marked with a statistical prevalence for falling on the penultimate syllable. As in Egyptian Arabic, there is a one-to-one relationship between tonally prominent

syllables and words in Nubi, but unlike in Egyptian Arabic, there is no evidence for any stress independent of the prominence tone in Nubi.

In summary, there are many types of relationship between stress and tonal prominence. One dimension along which languages can be classified is whether pitch-accents are projected bottom-up from word-level stress, as in English or Egyptian Arabic, or top-down under different principles from those governing word-level primary stress, as in Onondaga, Seneca, Cayuga, Chickasaw, Nubi, and possibly (depending on the analysis) Scandinavian and Papiamentu. Another cross-cutting parameter concerns the numerical mapping between phrasal accents and word-level stress. Thus, in many languages, e.g. English, Seneca, Chickasaw, and Papiamentu, only a subset of word-level stresses typically receive a pitch-accent in a phrase, whereas in others, e.g. Egyptian Arabic, Scandinavian, and Nubi, the number of pitch-accents is equal to, or nearly equal to, the number of word-level stresses.

In the rest of this chapter, we will focus on the relationship between word-level stress and tones that are unambiguously amenable to an analysis as pitch-accents. This includes both bottom-up (English, Egyptian Arabic) and top-down (Seneca, Onondaga, Cayuga, Chickasaw) prominence systems, but excludes both languages like Scandinavian and Papiamentu in which stress and non-boundary tonal prominence may fall on different syllables, as well as languages like Nubi, which lack evidence for stress independent of tonal prominence. As we will see, the examination of both bottom-up and top-down pitch-accent systems provides fertile ground for the examination of NonFinality, and more generally non-peripherality, effects at both the word and phrase level.

3.4.1 The typology

A convenience survey of the literature on word-level stress and phrasal pitch-accent was conducted in order to explore the range of variation observed in the types of relationships holding between stress and pitch-accents. Although the results of this typology must be regarded with caution due to the paucity of available descriptions teasing apart the two types of prominence, it nevertheless reveals some interesting distributional asymmetries in the nature of interactions between stress and pitch-accent.

3.4.1.1 Bottom-up pitch-accent

The English and Egyptian Arabic type pattern in which phrasal pitch-accents characteristically dock on a syllable carrying primary stress at the word level emerges as the dominant one cross-linguistically. It is typically the case that a phrasal pitch-accent falls on the rightmost content word under default semantic and pragmatic conditions. Thus, in the English sentence *The president likes*

Tennessee, a pitch-accent is more likely to fall on the primary stressed (final) syllable of *Tennessee* than on *president* barring some type of special focus on *president*.

The English-type system of bottom-up pitch-accent projection is observed in many languages (see Jun 2005a for discussion of pitch-accents in several languages), though it is worth noting that the sample is heavily skewed in favor of Indo-European languages. Crucially, languages of this type do not allow unstressed syllables to carry a pitch-accent except under extremely limited syllable-level contrastive focus conditions (van Heuven 1994).

3.4.1.2 Top-down pitch-accent

Another type of relationship between phrasal pitch-accent and word-level stress is the Northern Iroquoian (i.e. Seneca, Onondaga, Cayuga) and Chickasaw type, according to which the pitch-accent is delegated in 'top-down' fashion. In most cases, this pattern can be inferred from descriptions that refer to differences in stress in phrase-final words vs. words in other positions in a phrase under the plausible assumption that phrase-final words are more likely to carry a pitch-accent in the default case, as appears to be the dominant (e.g. in English and Chickasaw) pattern cross-linguistically (Ladd 1996). All of the top-down pitch-accent systems found in the survey display pitch-accent repulsion from the right edge, since the pitch-accent fails to dock on the final syllable and instead latches onto an earlier stressed syllable. With the exception of Chickasaw, another common feature of the top-down systems is that they select a syllable that carries some degree of stress, i.e. secondary stress, to promote to pitch-accent status, a pattern reminiscent of the rhythm rule of English discussed earlier. The selection of a secondary stressed (or unstressed syllable) as opposed to a primary stressed syllable as the docking site for the pitch-accent differentiates the top-down systems from those found in languages like English, with stricter (but not inviolable, cf. the rhythm rule) bottom-up pitch projection situating pitch-accents on phrase-final syllables carrying primary word-level stress.

Another language besides Chickasaw, Seneca, Onondaga, and Cayuga that instantiates top-down pitch-accent placement is Central Alaskan Yup'ik (Miyaoka 1985, 1996; Woodbury 1987), which displays an asymmetry in the stress patterns observed in phrase-final words and those found in phrase-non-final words that is amenable to interpretation in terms of an asymmetry between word-level stress, i.e. in phrase-non-final words, and phrasal pitch-accent, i.e. in phrase-final words. Words in both contexts display an iambic stress pattern according to which stress falls on heavy (CVV everywhere and CVC word-initially) syllables and on the second in a sequence of adjacent light syllables. However, phrase-final syllables are unstressed, whereas phrase-medial words have an additional stress on their final syllable, which, as in Seneca, Cayuga,

and Chickasaw, is independent of the rhythmic stress initiating at the left edge of the word. It is difficult to discern from sources whether the additional stress on the final syllable of phrase-medial words in Central Alaskan Yup'ik is the primary stress or not.

Chickasaw presents a particularly complicated case of top-down pitch-accent that offers insight into the reasons behind the observed asymmetries between stress and pitch-accent placement. Word-level stress in Chickasaw (Gordon 2004) falls on word-final syllables, on heavy (CVV, CVC) syllables, and on the second syllable in a sequence of two light (CV) syllables (2). A stressed vowel in a non-final CV syllable is rhythmically lengthened and counts as a long vowel for purposes of primary stress and pitch-accent (Munro and Ulrich 1984; Munro and Willmond 1994; Munro 2005; Gordon *et al.* 2000) (see the last two examples in (2)). Primary word-level stress falls on the final syllable in words lacking either a long or rhythmically lengthened vowel. In words containing a long or rhythmically lengthened vowel (CVV), the primary stress docks on the long/lengthened vowel. Words with multiple CVV syllables display variation, both inter- and intraspeaker, in whether the rightmost or leftmost CVV carries primary stress. Most typically, the rightmost CVV receives primary stress and the others receive secondary stress (as reflected in the stress markings in the last four examples in (2)).

(2) Chickasaw stress and rhythmic lengthening

ˌissoˈba	'horse'
ˌbaʃˈpo	'knife'
aˈboːkoˌʃiʔ	'river'
ˈbaːˌtamˌbiʔ	proper name
tʃaˌlakˈkiʔ	'Cherokee'
ˌokˌfokˈkol	'type of snail'
ˈnaːłtoˌkaʔ	'policeman'
ˌaːjoˈkaːˌtʃiʔ	'police station'
ˌaːkiˈlaːʔ	'wick'
piˈsaːliˌtok /pisalitok/	'I looked at him/her'
tʃiˌpiːsaˈliːˌtok /tʃipisalitok/	'I looked at you'

Stress is cued by a combination of increased duration and intensity and higher fundamental frequency (pitch) with duration being the most reliable cue to stress followed by intensity and then fundamental frequency. Unstressed syllables are also subject to various lenition processes, including vowel deletion, devoicing, and qualitative reduction. There is interspeaker variation in the relative strength of the various correlates of stress.

Word-level stress patterns are observed in words that appear in the non-final position of the prosodic domain Gordon (2003, 2005) terms the 'Intonational Phrase', following work on other languages within autosegmental metrical

frameworks such as ToBI (Pierrehumbert 1980; Silverman *et al.* 1992; Beckman and Hirschberg 1994; Pitrelli *et al.* 1994). The Intonational Phrase is characterized by, among other properties, a pitch-accent, phonetically a high tone, falling within the final word. The location of the pitch-accent differs depending on whether the Intonational Phrase is a question or a statement. In statements, the pitch-accent falls on the final syllable, which already carries some degree of stress at the word level. In questions, the pitch-accent is sensitive to a more complicated pattern governed by both phonological and morphological factors. I focus here on the phonological factors and refer the interested reader to the discussion of the morphological conditioning of the pitch-accent in Gordon (2003). The pitch accent falls on the final syllable of questions if this syllable contains a long or lengthened vowel (3a). Otherwise, it docks on the penultimate syllable provided it is heavy, where both CVV and CVC count as heavy (3b). If the final syllable is not CVV and the penult is neither CVV nor CVC, the pitch-accent lands on the antepenult, which is necessarily either heavy due to the process of rhythmic lengthening or word-initial (3c).

(3) Pitch-accent in Chickasaw questions

a. (ka͵ti:͵mihˈtã:) **sa͵ha:ˈʃá:** 'Why am I angry?'
(͵nanˈta:t) **͵okˈtá:k** 'What is a prairie?'

b. (͵nanˈta:t) **haˈtá:͵tʃim** 'What turned color?'
(͵nanˈta:t) **tʃiˈlák͵bi** 'What is dry and cracked?'
(kaˈti:͵jak͵ta) **aˈkán͵kaʔ** 'Where's the chicken?'

c. **ˈmálli͵tam** 'Did s/he jump?'
(͵nanˈta:t) **aˈbó:ko͵ʃiʔ** 'What's a river?'
(͵nan͵tahˈtã) **ˈpísam** 'What did s/he see?'

In all of the cases discussed thus far except for the last form in (3), the pitch-accent falls on a CVV or CVC syllable, syllables which are already stressed at the word level. In some cases, however, the pitch-accented syllable would only carry secondary stress at the word level. This holds true of all pitch-accented CVC penults and antepenults, of CVV penults and antepenults followed by a final CVV, and of statements ending in CV or CVC and preceded by a pre-final CVV syllable. To illustrate the case of pitch-accents docking on syllables with secondary rather than primary word-level stress, consider the word /tala:nompaʔ/ 'telephone', which is realized as taˈla:͵nom͵paʔ phrase-non-finally, as ta͵la:͵nomˈpáʔ at the end of a statement Intonational Phrase, and as ta͵la:ˈnóm͵paʔ at the end of an interrogative Intonational Phrase.

Even more interestingly, the overriding restriction against a pitch-accent on a final syllable other than CVV in questions means that a disyllabic word of the form CVCV(C) carries a pitch-accent on the CV first syllable, which is completely unstressed at the word level. For example, the word /fala/ 'crow' has final stress internal to a phrase, i.e. faˈla, and at the end of statements, where

it also carries a pitch-accent, i.e. faˈlá, but it has a pitch accent and initial stress at the end of questions, i.e. ˈfála.

In summary, all of the pitch accent systems discussed in this section have in common that the pitch accent either avoids final stressed syllables completely, as in Cayuga, Central Alaskan Yup'ik, and Onondaga, or is subject to more stringent weight criteria than stress, as in Chickasaw. Interestingly, another logically possible system that appears to be far less widely attested, if at all, is the inverse of these patterns, in which the pitch accent is attracted to rather than repulsed by the right edge. In this type of system, word-level stress would fall on a pre-final syllable but the phrasal pitch accent would dock on a final syllable. We return to this gap in the typology in section 3.7.

The top-down prominence systems identified in the survey appear to vary in whether the pitch accent docks on a syllable that carries secondary stress or is unstressed at the word level. Thus, Yup'ik, Seneca, and Cayuga appear to promote a syllable carrying at least secondary stress to pitch-accent status at the phrase level. In Onondaga, on the other hand, it appears that the pitch-accented syllable is not stressed at the word level. Finally, Chickasaw displays both patterns, placing pre-final pitch-accents on a secondary stressed syllable if one is available, but in disyllabic stems of the form CVCV(C) assigning the pitch-accent (in questions) to the initial syllable, which is completely unstressed. The diversity of patterns observed in the small sample of data examined here suggests the need for broader cross-linguistic investigation of the extent to which pitch-accent is dependent on word-level stress even in top-down systems that assign pitch-accents to syllables that do not carry primary stress at the word level.

3.4.2 Explaining the typology of stress/pitch-accent relations

In accounting for the relationship between stress and pitch-accent, it is instructive to consider the phonetic differences between the two types of prominence. Pitch-accent, as the name suggests, is primarily cued through fundamental frequency, whereas stress may be signaled through a variety of properties, including duration, intensity, fundamental frequency, and various segmental processes. Because pitch-accent is principally realized through the single phonetic dimension of fundamental frequency, it is potentially sensitive to other pitch events in the vicinity, including phrase-level pitch properties. As discussed in section 3.3, one of the cross-linguistically most salient phrase-level tone features is the boundary tone associated with the right edge of large intonational constituents. Many intonation systems seek to avoid realizing multiple tonal targets on a single syllable, just as many languages with lexical tone, e.g. Iraqw (Mous 1993) and Runga (Nougayrol 1990), have restrictions against contour tones on a single syllable (see Maddieson 1978; Clark 1983; Hyman 1988;

Zhang 2002 on the typology of contour tone restrictions). Tonal crowding is particularly problematic when the two tones have different target levels, e.g. if one is high and one is low, since it can be articulatorily and perceptually disadvantageous to temporally compress a fundamental frequency transition into a short time period.

There are different strategies for ameliorating the effects of tonal crowding cross-linguistically. Certain languages eliminate one or more of the tones in crowding contexts, the intonational analog to tonal deletion rules simplifying contour tones (Hyman 2007). For example, in Hungarian (Ladd 1983), the question tune consists of a low tone (the nuclear pitch-accent) on the primary stressed syllable of the focused word followed by a high-plus-low boundary tone at the right edge of the question, as in (4a). Because Hungarian imposes an upper limit of two tones per syllable (4b), the low component of the boundary tone is deleted if the final syllable would otherwise contain three tones (4c).

(4) Tonal crowding in Hungarian (Ladd 1983)

a. L* H L%
Beszél a miniszter? 'Is the minister talking?'

b. L*HL%
A tanár? 'the teacher?'

c. L* H (L)%
sör? 'beer?'

Other languages change the scaling of tones in crowding contexts so that the transition between tonal targets is less demanding, i.e. has a shallower slope. For example, in Greek (Arvaniti and Baltazani 2005), the second in a sequence of L* + H pitch-accents often undergoes undershoot of the L* component.

A third strategy for reducing tonal crowding is to lengthen the segments on which the tones are realized. For example, Japanese (Venditti 2005) and Korean (Jun 2005b) lengthen final syllables that are associated with boundary tones consisting of multiple tonal targets, e.g. LH% or HL%. Final lengthening in Swedish also allows for the realization of both lexical accents and boundary tones (Bruce 2005).

Still another possible response to tonal crowding is to shift the two tonal targets in the time domain such that they are farther apart. For example, a pre-nuclear H* pitch-accent in English occurs earlier in a syllable immediately preceding a nuclear accented syllable than in a syllable not followed by an accented syllable (Silverman and Pierrehumbert 1990). The LH prominence

tone in Papiamentu is also shifted leftward in sentence-final position under pressure from a final boundary tone (Remijsen and van Heuven 2005).

This tonal shifting response offers an explanation for languages in which prominence in phrase-final words, inferred to be the pitch-accent, is repelled from word-final syllables that carry stress internal to the phrase. An explanation of pitch-accent placement in terms of tonal crowding avoidance is also supported by the Chickasaw sensitivity of pitch-accent placement to both boundary tone type and syllable weight. Thus, questions have a low boundary tone that triggers retraction of the high pitch-accent to a non-final syllable (unless the final syllable is CVV), whereas statements lack this low boundary tone and accordingly allow a pitch-accent on any type of final syllable. Only questions thus require a transition from a high pitch-accent to a low boundary tone. This transition is only possible if the final syllable contains a maximally sonorous long vowel, which is best equipped to handle the transition from high to low tonal targets. There is a parallel found in many tone languages, e.g. Tubu (Lukas 1953) and Somali (Berchem 1993), which allow contour tones only on syllables containing a long vowel (see Maddieson 1978; Clark 1983; Hyman 1988; Zhang 2002 for the typology of weight-sensitive tone restrictions).

Parallel to statements, there is also no tonal transition required in phrase-internal words in Chickasaw. For this reason, there is no compulsion to retract word-level stress from final syllables in words that are not in final position of a phrase; hence the docking of word-level stress on final syllables.

A phonological analysis of pitch-accent placement based on tonal crowding is further supported by phonetic timing patterns observed in Chickasaw. Gordon (2008) finds that that the actual F0 peak associated with the pitch-accent in Chickasaw occurs progressively earlier in accented syllables as the distance between the accented syllable and the end of the phrase decreases. The peak is thus timed to fall at the beginning of final long vowels, during the second half of accented long vowels in the penult, and near or after the end of accented long vowels in the antepenult. The pitch-accent is also timed earlier in accented CVC syllables in the penult than in the antepenult.

An intonationally driven account of stress and pitch-accent finds additional support from certain phonetic details observed in Iroquoian languages. Pitch traces in Doherty's (1993) work on Cayuga show a terminal drop in F0 utterance-finally as well as an F0 peak associated with accented syllables, which together provide direct support for the potential for tonal crowding in Cayuga. Seneca (Chafe p.c.) utterances are likewise associated with a terminal F0 fall in the default case of statements while accented syllables have an F0 peak. In Onondaga, the pitch peak associated with stress characteristically precedes the stressed syllable utterance-finally (Michelson 1988). The early realization of the pitch peak may be regarded as a further repulsion of the pitch

peak from the end of the utterance along the lines of the inverse correlation between the proximity of the accented syllable to the right edge of questions and the timing of the pitch peak within the accented syllable in Chickasaw. Historically, the ancestor of modern Northern Iroquoian languages is reconstructed as having penultimate accent (Chafe 1977; Michelson 1988), which the account advanced here would attribute to tonal crowding avoidance. The early timing of the pitch peak in Onondaga relative to the stress may thus be regarded as an extension of the tonal repulsion effect already present in the proto-language.

Following the discussion in Hyman (1977) and Gordon (2000b), the intonational analysis of pitch-accent repulsion from final syllables can be extended to account for the preponderance of languages reported in grammars to have penultimate rather than final stress under the assumption that the reported stress patterns reflect those found in words uttered in isolation where, under the default pronunciation, there is likely to be a low boundary tone compelling the retraction of the stress, i.e. the pitch-accent in this context, from the final syllable to the penult. The tonal account of final stress repulsion is particularly attractive given the contrast between the prevalence of reports of penultimate stress and the rarity of descriptions reporting the left edge counterpart to penultimate stress: peninitial stress. Thus, Hyman (1977), Gordon (2002), and van der Hulst and Goedemans (2009) all observe that penultimate stress is substantially more common than peninitial stress in their databases: seventy-seven languages vs. twelve in Hyman (1977), fifty-four languages vs. ten in Gordon (2002), and seventy-seven languages vs. thirteen in van der Hulst and Goedemans (2009). The asymmetry in the relative frequency of penultimate and peninitial stress also falls out naturally if one assumes that the majority of stress descriptions are referring to isolation forms where the stress is actually a pitch-accent. Penultimate stress is common due to the pervasiveness of final boundary tones, in particular final low boundary tones, whereas the striking rarity of peninitial stress is attributed to the paucity of left-edge boundary tones. Antepenultimate stress is also amenable to an explanation in terms of tonal crowding avoidance under the assumption that some languages might deem it preferable to allow an entire syllable, the penult, to intervene between the pitch-accent and the boundary tone. This account is supported by both the early timing of the pitch-accent in the penult relative to the antepenult in Chickasaw questions, as well as the early realization of the pitch-accent even in Onondaga utterance-final words with stress on the penult.

Obviously, the proposed link between tonal crowding and stress requires further evaluation, which will become increasingly feasible as the number of thorough descriptions of both word-level stress and phrase-level intonation expands. As a final note, it is worth mentioning that there are other potential

contributing factors to final prominence avoidance, including the subglottal pressure trough characteristic of final position of the utterance and the opening of the vocal folds in anticipation of breathing. These properties are both antagonistic to prominence since they are often associated with devoicing (Gordon 1998; Barnes 2002; Myers 2012), which virtually precludes the possibility of realizing intonational information. Together with tonal crowding avoidance, final devoicing further militates against final pitch-accents.

3.4.3 Left-edge pitch-accent repulsion

Although pitch-accent repulsion is primarily observed at the right edge of phrases, there is some evidence that it also exists to a more limited extent at the beginning of phrases. Pitch contours characteristic of utterances generally display a declination from beginning to end. Prior to this declination pattern, there is typically a slight rise in fundamental frequency at the very beginning of the utterance as subglottal pressure rises. If the fundamental frequency peak at the beginning of the utterance is delayed sufficiently, it could fall in the second rather than the first syllable in the absence of any pitch-accent at or near the right edge of the phrase. Under this approach, the relatively rare case of peninitial prominence can be analyzed as a pitch-accent phenomenon parallel to the analysis of penultimate stress. Let us briefly consider two languages, Northwest Mari and Korean, that provide evidence that peninitial stress may be grounded in intonational factors.

Stress in Northwest Mari (Ivanov and Tuzharov 1970) falls on the rightmost non-final heavy syllable, where heavy syllables contain a full vowel. In words lacking heavy syllables, stress is described as falling on the first or second syllable, depending on the quality of the first vowel. If the first vowel is a rounded central vowel, stress consistently falls on the second syllable, whereas, if the first vowel is an unrounded central vowel, stress variably docks on either the first or the second syllable. Interestingly, Ivanov and Tuzharov state that this pattern is characteristic of words in isolation. For words embedded in an utterance, stress is weight-sensitive and is oriented toward the right edge. We may thus infer that the default stress falling near the left edge of an isolated form is a feature of a phrasal domain rather than a word. This fact is consistent with an intonational analysis attributing prominence to a fundamental frequency peak occurring early in the phrase. The placement of the pitch peak on the second rather than the first syllable would be consistent with the characteristic slight delay in the pitch peak associated with the utterance beginning. That this delay is quite short is supported by the fact that it occurs when the first vowel is central and thus likely to be phonetically short (see Gruzov 1960 for supporting phonetic data from the literary Mari dialect, which makes the same weight distinction as Northwest Mari).

The intonationally driven account of Northwest Mari stress is consistent with de Jong's (2000) hypothesis that at least certain types of weight-sensitive stress may find their roots in intonation patterns. Focusing on Korean, which has alternately been described as either a stress or an intonation language, de Jong suggests that the F0 peak in the low–high tonal sequence at the beginning of the Accentual Phrase (Jun 1993) could easily be construed as stress. The fact that the F0 peak characteristically falls after a short (CV) phrase-initial syllable but during a long (CVX) initial syllable offers an explanation for descriptions of stress that place stress on a heavy initial syllable, otherwise on the second syllable. Consistent with the account of intonationally driven stress proposed in this chapter, de Jong hypothesizes that the Korean facts suggest a plausible historical mechanism for weight-sensitive stress to develop from intonation. The de Jong account of the potential intonational origins of weight-sensitive stress is discussed further in the next section.

3.4.4 Pitch-accent and syllable weight

The relationship between syllable weight and the intonationally driven account of prominence is a multifaceted one. On the one hand, as de Jong (2000) points out, there is a natural relationship between weight in peripheral syllables and phrasal tones. At the left edge of a phrase, the distance between an initial low tone and a following high tone may fall within the span of an initial heavy (CVX) syllable but exceed the characteristic duration of an initial light (CV) syllable. The result is a high tone on an initial heavy syllable, but on the syllable following an initial light syllable. Reinterpretation of the high tone as stress would result in a weight-sensitive stress system with stress on an initial heavy syllable, otherwise on the second syllable. This stress pattern is attested in Hopi (Jeanne 1982). The same potential for weight to play a role in the reanalysis of a phrasal high tone as stress also exists at the right edge of a phrase. A final heavy syllable could provide sufficient time to realize the high component of a final high-plus-low tone sequence, whereas the high tone might fall to the left of a final light syllable. Given reanalysis of the high tone as stress, the result would be a stress system with stress on a final heavy syllable, otherwise on the penult, a system found in several languages, including Tol (Fleming and Dennis 1977) and Bergüner Romansh (Kamprath 1987).

Another avenue for weight to interact with the intonational underpinnings of stress is instantiated by Chickasaw, which, it may be recalled from section 3.4.1.2, places the pitch-accent on a final syllable in questions only if it is CVV. The ability of CVV to support a sequence of H* pitch-accent followed by L% boundary tone has an analog in tone languages that allow contour tones only on CVV, and is phonetically motivated in terms of the more salient backdrop for a contour tone provided by a long vowel relative to other rimes. Other languages

that preferentially allow stress on final CVV but position stress to the left of a final syllable that is not CVV include Klamath (Barker 1964), Cuna (Holmer 1947), Aleut (Bergsland 1994; Rozelle 1997), Kadazan (Hurlbut 1981), Junin-Huanca Quechua (Cerrón-Palomino 1976), Huallaga Quechua (Weber 1989), and Aymara (Briggs 1976). The left-edge counterpart to this weight distinction entailing stress on initial syllables only if they contain a long vowel, e.g. Konda (Krishnamurti and Benham 1998), is also amenable to an intonationally driven account along the same lines as the one proposed for the right edge.

It is also possible for a heavy syllable to attract prominence away from a syllable that might otherwise be intonationally prominent. This phenomenon is plausibly observed in unbounded stress systems in which a heavy syllable attracts stress from a peripheral syllable that is reported to be stressed in the absence of heavy syllables elsewhere in the word. One such system, that of Northwest Mari, was discussed earlier in section 3.4.3. What is difficult to determine from most descriptions of unbounded stress systems is whether the default prominence on a peripheral syllable is completely absent or merely overshadowed in the face of a non-peripheral heavy syllable. Chuvash is exceptional in being explicitly described by Dobrovolsky (1999; see section 3.6.2) as preserving the initial tonal peak even in words with a heavy syllable to the right of the first one. If the default prominence is preserved, as in Chuvash, even in the face of a heavy syllable removed from the default site, this suggests that the default prominence is due to a boundary tone.

It is interesting to note that nine of the eleven languages with default-to-opposite stress discussed in Gordon (2000a) are default-to-left. A further seven of ten languages with default-to-same-side stress in Hayes (1995) have the default as the left side,[2] yielding a total of sixteen out of twenty-one (76%) unbounded systems with a default prominence on the initial syllable. It is possible that these stress systems may represent a hybrid type of prosodic system, entailing, as in Chuvash, a combination of either pitch-accentual or stress prominence on non-initial heavy syllables plus an initial boundary high tone contributed by the intonational system. Of the five languages with default-to-right stress, four position the default stress on the final syllable, which may be an intonational effect (see section 3.6.1). One of the five languages with default stress at the right edge, Western Mari (Itkonen 1955), positions the default stress on the penultimate rather than the final syllable, possibly suggesting an intonationally driven pitch-accent repulsion effect. It is also interesting that four of the languages with default-to-left stress also display restrictions on final

[2] An additional case of default-to-same-side stress (not included in the ten default-to-same patterns included in the text) that Hayes (1995) discusses, that of Khalkha Mongolian, is treated as a default-to-opposite system by Gordon (2000a), following Bosson (1964), Poppe (1970), and Walker (1997).

stress pertaining to heavy syllables. Final heavy syllables in Northwest Mari fail to attract stress, only superheavy final syllables carry stress in Classical Arabic, and stress falls on a final heavy syllable in Khalkha and Buriat only if there is no other heavy syllable in the word. Avoidance of stress on final heavy syllables where there is a pre-final heavy syllable is not confined to unbounded stress systems but also is found in languages with stress windows at the right edge. For example, the stress pattern reported for Hindi by Kelkar (1968) entails stress on the rightmost non-final syllable which is heaviest along the tripartite scale CVXX > CVX > CV. Awadhi (Saksena 1971) and Sarangani Manobo (DuBois 1976) display essentially the same pattern except that they employ a two-syllable window rather than a three-syllable window and only have two degrees of weight, CVX > CV in Awadhi and full vowels > schwa in Sarangani Manobo.

3.5 Synchrony vs. diachrony: the place of word-level stress in the typology

The tone-driven analysis of peripheral stress avoidance raises questions about the place of true word-level stress in the typology of prominence from both a distributional and an explanatory perspective. In this section, we explore this issue, focusing for expository purposes on the typologically common pattern of penultimate prominence, though the same questions pertain to the considerably rarer cases of peninitial prominence as well.

Because tonal crowding is primarily an issue at the end of phrases, it is not clear why a language might also retract stress from the final to the penultimate syllable of a *word*, where tonal crowding is not likely to be an issue. Although many languages classified as having penultimate stress might in fact have penultimate pitch-accent, there are some languages in which penultimate prominence truly reflects word-level stress. This includes some well-studied languages with consistent or dominant penultimate stress, e.g. Polish, Spanish, and Italian.

The hypothesis I advance here (following Hyman 1977) is that true cases of penultimate stress ultimately have their roots in penultimate pitch-accent, which became generalized from a phrasal domain to the word level through a process of grammaticalization. This hypothesis assumes that prosodic patterns associated either with words uttered in isolation or words appearing in final position of an utterance, where there is likely to be a pitch-accent, are weighted more heavily than other instantiations by speakers seeking to construct a general rule of stress assignment pertaining to all contexts in which a word appears. Generalizing a pattern across different instantiations of a word has the advantage of minimizing variation, just as analogical leveling in morphological paradigms has the virtue of reducing allomorphy. The bias in favor

of isolation and/or phrase-final tokens over phrase-medial tokens may be rooted in either a statistical predominance in the frequency of occurrence of isolation and/or phrase-final tokens relative to phrase-medial tokens, or in a perceptual bias that renders isolation and/or phrase-final instantiations more salient. Either of these scenarios seems feasible and both are consistent with other phenomena that are also likely to have originated as phonetically motivated patterns at the phrasal level that have been generalized to the word level. For example, obstruent devoicing finds a clear motivation in utterance-final position where aerodynamic factors conspire against sustained voicing of obstruents (Westbury and Keating 1986). Many languages nevertheless generalize devoicing to smaller domains, where the phonetic conditioning factors behind devoicing are not as compelling.[3]

Although this explanation for true penultimate stress appears plausible, it is admittedly speculative. Given our limited typological knowledge about the interaction between stress and pitch-accent, it is unclear how many languages have penultimate stress as opposed to penultimate pitch-accent. It is conceivable that languages like Chickasaw, displaying different stress and pitch-accent patterns, are not mere outliers but rather that they constitute the statistical majority of languages. Without more detailed case studies of individual languages it will be impossible to tackle this issue on a broad typological scale. In lieu of such data, however, there might be certain diagnostics that could provide some insight into whether a particular language has penultimate pitch-accent or penultimate stress. One potential criterion is the presence of lexically marked exceptions, either in roots or affixes, to the general location of prominence. If prominence were truly a phrasal pitch-accent one would not expect lexical exceptions to exist. Thus, all of the languages mentioned above as displaying dominant penultimate word stress – Polish, Italian, and Spanish – have lexical items with stress on a syllable other than the penult. It is also interesting to note that Onondaga (section 3.4.1.2), which asymmetrically has final stress at the word level but dominant penultimate pitch-accent at the phrase level, possesses morphemes that exceptionally attract prominence to final syllables both at the word and phrase level, as well as morphemes that trigger retraction of prominence to the antepenult (Chafe 1970). This indicates that stress has become lexicalized at the word level and that the lexical stress also attracts the pitch-accent in phrase-final position, an instance of bottom-up pitch-accent placement existing alongside the top-down accent placement otherwise characteristic of Onondaga.

[3] Evidence from loanword phonology further hints at the importance of isolation forms in conditioning the transfer of prominence from one language to another. Rice (this volume) discusses the case of Navajo, a tone language that has reanalyzed stress from Spanish loanwords as high tone. This reinterpretation of stress as high tone makes sense if isolation forms, where the stress plausibly carries a high pitch accent, serve as the basis for the borrowing.

Another enticing diagnostic for determining whether a description of stress truly reflects word-level stress as opposed to phrasal pitch-accent could be the occurrence of binary stress propagating from the prominence reported to be the primary one. Under the assumption that pitch-accents are not assigned rhythmically, the existence of an alternating stress pattern presumably would not be attributed to mere pitch-accent. Placing stress on the penultimate syllable and on alternating syllables preceding the penult conforms to the trochaic template, which is independently preferred over its iambic counterpart both typologically in Quantity-Insensitive stress systems (Hayes 1995; Gordon 2002) and in language acquisition (Allen and Hawkins 1978; Adam and Bat-El 2009).[4] It is possible that placement of a pitch-accent on the penult sets up the trochaic template that is prone due to its eurhythmy to be extended leftward when the pitch-accent becomes phonologized as stress at the word level. It is also conceivable that the naturalness of the trochaic prominence pattern, working in conjunction with tonal crowding avoidance, reinforces the adoption of penultimate pitch-accent itself. Bolinger (1980: 44) alludes to this possibility when he suggests that "an intonational prominence is set off best when there are non-prominences to either side" and "penultimate position is the best compromise between climax and clarity".

Regardless of what future research reveals to be the relative frequency of penultimate pitch-accent vs. penultimate stress, the existence of documented cases of each in the relatively small data sample presented here indicates that mechanisms for accounting for both are necessary for an adequate theory of prominence.

3.6 The basis for initial and final prominence

Thus far, we have offered an account of peripheral stress avoidance grounded in tonal crowding effects, which operate either synchronically to produce penultimate, antepenultimate, or peninitial pitch-accent or diachronically via a process of phonologization of phrasal pitch-accent to word stress. This raises the question of how initial and final stress should be accounted for. Both locations for stress are quite common cross-linguistically, as shown in Table 3.1, which shows the number of languages with initial, peninitial, antepenultimate, penultimate, and final stress in surveys conducted by Hyman (1977), Gordon (2002), and van der Hulst and Goedemans (2009).

In sections 3.6.1 and 3.6.2 we examine these two docking sites for stress, arguing that, unlike non-peripheral stress, they find a natural explanation in terms of *both* phrasal and word-level considerations. Initial and final stress

[4] Thanks to Harry van der Hulst for reminding me of the potential contribution of rhythmic euphony in accounting for penultimate prominence.

Table 3.1 *Number of languages displaying different stress patterns in three surveys*

	Hyman (1977)		Gordon (2002)[a]		Van der Hulst and Goedemans (2009)[b]	
Location	No.	%	No.	%	No.	%
Initial	114	37.3	57	30.6	77	36.5
Penultimate	77	25.2	53	28.5	77	36.5
Final	97	31.7	59	31.7	38	18
Antepenultimate	6	2.0	7	3.8	6	2.8
Peninitial	12	3.9	10	5.4	13	6.2
Total	306		186		211	

[a] Languages in the Gordon (2002) survey have a single stress per word.
[b] The number of languages reflects percentage of languages returned by entering the query for each stress location (without any additional filters) using the online version of the StressTyp database (www.unileiden.net/stresstyp/index.htm).

are amenable to an intonational account, parallel to penultimate and peninitial stress, not in terms of tonal crowding avoidance but rather in terms of phrase-level or boundary tones. In addition, initial and final stress are natural docking sites for stress even at the word level due to their demarcative function in signaling the beginning and end points, respectively, of words.

3.6.1 Final stress

If one assumes that many, if not the majority of, cases of penultimate stress in the literature actually reflect phrase-level pitch-accent, it is logical to adopt the same assumption about descriptions of final stress. If so, then one wonders why so many languages would permit a pitch-accent on a final syllable that also is associated with a low final boundary tone in the default case. Pursuing an intonational account of final stress, there are at least two tacks to take in response to this query.

One possibility is that many languages simply allow crowding of a pitch-accent and a boundary tone onto the same syllable, much as English permits multiple tones on a single syllable. A pitch-accented word with final stress, such as *Tennessee*, is thus typically associated with both a H* pitch-accent and L% boundary tone in neutral declaratives. English, in fact, is quite tolerant of substantially more tonal crowding than found in this example. The characteristic lengthening of final syllables (Wightman *et al.* 1992) facilitates the crowding of intonational tones onto final syllables much as many tone languages allow

more complex tones in final position relative to other contexts (Maddieson 1978; Clark 1983; Zhang 2002; Hyman 2007).

Another possibility is that some languages have different tonal inventories than the canonical H* pitch-accent and L% boundary tone that seem to predominate cross-linguistically. For example, in some languages, a L* pitch-accent or either a H% boundary tone or no boundary tone might be prevalent, in which case the issue of tonal crowding would not be so acute. This situation, in fact, holds of Chickasaw statements, where there is characteristically no boundary tone that would necessitate a rapid transition from the high pitch-accent to a low target. In some languages, it might not be a large phrasal boundary tone but rather a high tone characteristic of a small phrase that is responsible for the final prominence. For example, the Accentual Phrase final high tone in French (Jun and Fougeron 1995) accounts for the final prominence that is often interpreted as stress.

A final possibility is that many cases of final prominence reflect true word-level stress. Final stress has a clear functional benefit in signaling the ends of words, which aids the listener in the parsing of an utterance. I would thus hypothesize that, relative to penultimate stress, a larger percentage of the reported cases of final prominence in the literature reflect true word-level stress.

3.6.2 Initial stress

Initial stress has the same advantage as final stress in serving the role of demarcating word boundaries. There are also, however, intonational factors that could be relevant in conditioning initial prominence. Cross-linguistically, pitch typically declines throughout an utterance, with the highest pitch occurring at or near the beginning. It is plausible that this initial pitch peak could be interpreted as stress.

The prosodic system of Chuvash offers support for an intonational account of initial stress along these lines. According to Krueger (1961), stress in Chuvash falls on the rightmost heavy syllable (a syllable containing a vowel other than schwa), otherwise on the initial syllable. A more recent phonetic study by Dobrovolsky (1999), however, suggests that the initial stress is actually attributed to intonational prominence rather than true word-level stress. In his study, Dobrovolsky measured the peak intensity, the average intensity, the duration, the fundamental frequency, and the intensity integral (intensity integrated over time; see Beckman 1986 for discussion of this measure) for a corpus of disyllabic words in which the weight of both syllables was varied such that all combinations of heavy and light syllables were attested. Dobrovolsky found that, while at least certain intensity measures differentiated stressed from unstressed syllables in most word shapes, light syllables were not typically

characterized by greater peak, average, and total intensity, nor by increased duration, even when occurring in positions predicted to carry stress, i.e. in the initial syllable in words with no heavy syllables that would attract stress away from the left periphery. Rather, the first syllable characteristically had the highest fundamental frequency, which subsequently fell throughout the rest of the word. This initial peak in fundamental frequency was a consistent property of the initial syllable, even when it was not predicted to be stressed. As Dobrovolsky suggests, the picture which thus emerges is one in which certain prominence correlates do not pattern together. At least one of the intensity and/or durational correlates of stress are associated with stressed heavy syllables, whereas a fundamental frequency peak is consistently associated with the initial syllable independent of syllable weight. Dobrovolsky interprets this mismatch as a divergence between intonational and stress prominence. Heavy syllables have the potential to be stressed as indicated by increased duration and/or intensity, whereas the initial syllable is prominent by virtue of its intonational properties.

There is an important issue which Dobrovolsky's (1999) study leaves unresolved. It is unclear whether the fundamental frequency peak and subsequent fall found in Dobrovolsky's study is a word property or is a feature of a larger intonational unit. If the latter scenario is true, then we would not expect generally to find a fundamental frequency peak in words in non-initial position of this larger intonational unit. Unfortunately, we are not in a position to address the nature of intonation domains in Chuvash. However, given the fact that intonational properties cross-linguistically tend to be associated with prosodic units larger than the word, it is quite plausible that the fundamental frequency peak in Dobrovolsky's data is not a feature of all words but is a feature of a domain larger than the word.

3.7 Toward a typology of stress/pitch-accent interactions: some predictions

Thus far we have focused on showing how a number of observations attributed to the typology of word-level stress may be better explained if one assumes that the stress reported in many language descriptions is actually either a phrasal pitch-accent or a phrasal tone. The general schema is for pitch-accents and phrasal tones to be attracted to phrasal edges, presumably as a boundary signal to aid the listener in parsing an utterance. Competing with edge attraction is a tendency for pitch-accents to be repulsed from peripheral syllables due to constraints against tonal crowding. Final pitch-accents are particularly vulnerable to edge repulsion since the right edge of phrases is often associated with a terminal pitch fall. Initial pitch-accents are also potentially subject to a shift away from the periphery due to the tendency for subglottal pressure and pitch to rise slightly

at the left edge of an utterance. Because the factors conditioning edge repulsion of the pitch peak are relatively weak at the left edge, it is not surprising that peninitial prominence is rare cross-linguistically. It also follows that the left-edge counterpart to antepenultimate stress, post-peninitial stress, appears to be unattested.

In summary, all five reported docking sites for prominence, initial, peninitial, antepenultimate, penultimate, and final syllables, find an explanation in terms of pitch properties characteristic of phrases rather than individual words. If, however, pitch factors are responsible for the typological distribution of pitch-driven prominence, the typology of true word-level stress is predicted to be relatively impoverished to that of pitch-accents. Assuming that word-level stress also serves the purpose of facilitating the morphosyntactic parse, both initial and final stress are natural occurrences. It is more difficult, however, to account for apparent edge repulsion effects at the word level since there are less likely to be any pitch properties bounded by the word that would repel stress from an edge. The question is then how we can account for peninitial, penultimate, and antepenultimate prominence that truly reflects word-level stress as opposed to pitch-accent. The first approach to this problem is to ascertain how many true instances of these stress locations are actually word phenomena as opposed to phrasally bound. Unfortunately, we are not in a position to assess the typological frequency of these non-peripheral stress sites. It is likely, however, as argued earlier, that many of the reported cases of stress in general, including both peripheral and non-peripheral stress sites, actually reflect phrasal pitch characteristics rather than word-level stress. Since there are so few cases of peninitial and antepenultimate stress in the literature, these patterns are particularly vulnerable to complete reanalysis as pitch-driven phrasal prominence. The strongest possible prediction made by the intonation-driven account of prominence is thus that there are only two docking sites for true word-level stress: the initial syllable and the final syllable. This contrasts with the richer inventory of five docking sites for pitch prominence at the phrase level: initial, peninitial, antepenultimate, penultimate, and final syllable.

As discussed in section 3.5, we know, however, that it is not possible, at least in the case of penultimate prominence, to attribute all cases to phrasal pitch phenomena at least synchronically, even if non-peripheral word-level stress may diachronically originate as a pitch-accent that has been generalized to the word. Although the existence of penultimate word-level stress vitiates the predictive power of the intonation-driven approach to stress typology, there are nevertheless some predictions that can be made about the relationship between word-level stress and phrasal pitch-accent. There are two possible scenarios that are expected to emerge cross-linguistically. First, some languages will be like English in assigning pitch-accents to the same syllable that carries word-level stress. Others will be like Chickasaw in employing orthogonal principles from

Table 3.2 *The typology of prominence systems*

	Edge repulsion		
	Word	Phrase	Languages
Symmetrical	Yes	Yes	English, Egyptian Arabic
	No	No	Hebrew, Farsi
Asymmetrical	No	Yes	Chickasaw, Cayuga, Seneca, Central Alaskan Yup'ik, Onondaga
	No	No PA	Wolof
	Yes	No	Unattested?
	Yes	No PA	Unattested?

word-level stress in situating pitch-accents. Crucially, in languages of this latter type, only phrasal prominence and not word-level stress is predicted to display edge repulsion effects since the motivating factors behind edge repulsion are only in play at the phrasal level. This effectively excludes systems in which word-level stress is peninitial, penultimate, or antepenultimate, while phrasal prominence is initial or final. For example, we would not expect the inverse of Chickasaw, where the pitch-accent is consistently final but word-level stress often retracts to the penultimate or antepenultimate syllable.

If the only mechanism for word-level stress falling on a non-peripheral syllable is historical reanalysis of phrase-level prominence as word-level stress, non-peripheral stress should only occur in languages in which a pitch-accent may fall on the same non-peripheral syllable as the stress. This situation occurs in English, which has many words with non-final stress and places the pitch-accent on the same non-final syllables carrying word-level stress.

The predictions of the intonationally driven approach to prominence typology are summarized schematically in Table 3.2 according to two dimensions: whether prominence is repelled from a peripheral syllable and whether the location of prominence is the same at the word and phrase levels.

There are six possible relationships between word-level stress and phrasal prominence shown in Table 3.2 if we add the possibility of a language lacking a phrasal pitch-accent (indicated by 'No PA' in the table).[5] Two are

[5] Another a priori possibility, a language with phrasal pitch accent (either on a peripheral syllable or not) but an absence of word stress, is omitted from the table since the tonally driven account of prominence makes no predictions about its existence. It is also in practice difficult to know whether phrase-level tones are attributed to pitch-accents or boundary tones in the absence of word-level stress with which to compare the realization and location of the phrase-level tones. This issue, for example, is evident in the debates about the prosodic analysis of French, Korean, and Indonesian (see section 3.3).

symmetrical in that prominence docks on the same syllable both at the phrase and word level and four are asymmetrical in positioning prominence on different syllables at the two prosodic levels. The symmetrical prosodic types can be divided according to whether prominence falls on a peripheral syllable at both the word and phrase level or whether it is repelled from the periphery at both levels. English instantiates the latter type of symmetrical system since lexical items with non-final stress position phrasal pitch-accent on the same syllables with non-final stress. Hebrew exemplifies a symmetrical system with peripheral prominence, on the final syllable, at both the word and phrase level (Becker 2003). Farsi (Mahjani 2003) also stresses word-final syllables (with morphological effects producing non-final stress in certain forms) and assigns them pitch-accents.

The asymmetrical systems can be subdivided based on whether prominence repulsion occurs at the word or phrase level. In one type of asymmetrical system, instantiated by Cayuga, Central Alaskan Yup'ik, Onondaga, Seneca, and Chickasaw, edge repulsion is observed at the phrase level but not the word level. In another type of asymmetrical system, word-level stress falls on a peripheral syllable but there is no phrase-level pitch-accent. A language that appears to fit this profile is Wolof, which has word-level stress on either the initial or second syllable depending on weight (Ka 1988) but which has phrase-level intonation contours which are projected independently of stress (Rialland and Robert 2001).

In the other two subtypes of asymmetrical systems, edge repulsion applies only at the word level and there are either no pitch-accents, i.e. Wolof but with non-peripheral word-level stress, or pitch-accents that fall on a peripheral syllable, i.e. the inverse of Onondaga with stress on the penultimate syllable and pitch-accent on the final syllable. It is these types of system that are hypothesized to be unattested since they would involve edge repulsion at only the word level, precisely where the intonational factors claimed here to motivate peripheral prominence avoidance are absent.

Whether the predictions of this six-way typology turn out to be corroborated must await further detailed investigation of the relationship between word-level stress and phrase-level prominence for a broader sampling of languages. The proposed taxonomy may nevertheless be regarded as a useful hypothesis guiding future studies of prominence in different prosodic constituents.

3.8 Conclusions

This chapter has suggested that a large portion, if not the majority, of the prosodic typology that is currently understood to refer to stress may actually reflect phrasal prominence associated with tonal events occurring at

or near phrase edges. Several features of the cross-linguistic distribution of the 'stress' typology support this view. First, the asymmetry in the relative frequency of penultimate and peninitial stress finds an explanation in the fact that tonal crowding factors are primarily, though not exclusively, found at the right edge of phrases, where a transition from high pitch-accent to low boundary tone occurs. Second, the existence of several languages in which final stress avoidance is observed only in phrase-final words is consistent with an analysis appealing to tonal crowding avoidance. Third, the Chickasaw asymmetry between questions which have a L% boundary tone and display final H* pitch-accent avoidance on all but the most sonorous syllables, and statements which lack a L% boundary tone and permit H* on all final syllables, supports the intonational view of prominence. Finally, descriptions of initial prominence in languages like Chuvash and Northwest Mari suggest a subtler and cross-linguistically less pervasive effect of initial prominence avoidance that accords with the predictions of an intonation-driven account. While an intonational account has the potential to dramatically impact the stress typology landscape by reassigning many 'stress' patterns to the class of 'pitch-accent' patterns, this redistribution offers an exciting opportunity for constructing new typologies of both stress and pitch-accent and the relationship between the two. Furthermore, it potentially opens up fertile new ground in the formal analysis of both phenomena.

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4 The separation of accent and rhythm: evidence from StressTyp

Rob Goedemans and Harry van der Hulst

4.1 Introduction

This chapter offers a demonstration of various applications and uses of the StressTyp dataset (Goedemans and van der Hulst 2009, 2010; Goedemans *et al.* 1996a, 1996b, 1996c). Drawing on previous studies, the first part of this chapter presents overviews of the major types of stress systems as these are represented in StressTyp, both in tabular form and plotted in maps. In the second part of this chapter we focus on the use of StressTyp in providing support for a particular theoretical claim, namely the separation of (primary) stress and rhythm. Many languages display stress patterns that involve a distinction between one primary stress and one or more non-primary stresses (or rhythmic beats). Approaches to the formal analysis of stress patterns differ in various ways, one being whether primary stress and non-primary stress are derived in terms of a single algorithm or two separate algorithms. Van der Hulst (1996, 2009, 2010, 2012, this volume, chapter 11), for example, presents a formal theory of word stress that separates the representation of primary stress (called the 'accent') from the representation of syllables that are rhythmically strong. The basic idea is that accent is calculated first, while rhythmic beats are accounted for independently (at a later derivational stage), although 'with reference' to the accent location.[1] This approach, which dates back to van der Hulst (1984), has been called 'a (primary) accent first theory' ([P]AF), e.g. in van der Hulst (1996, 1999, 2000, 2009). The theory was developed as an alternative to standard Metrical Phonology (Liberman and Prince 1977; Vergnaud and Halle 1978; Hayes 1980, 1995; Halle and Vergnaud 1987; Idsardi 1992), which develops a unified account of primary and rhythmic stress.

In previous work, we have supplied several arguments that support the 'separation theory'. In this chapter, we review these arguments, this time with the specific goal of providing quantitative evidence for them with data from StressTyp, a typological database containing information about word accent

[1] In a non-derivational approach we would say that rhythmic structure is governed by constraints that are subordinate to the constraints that govern accent (as is possible in the approach presented in Prince and Smolensky 1993).

and rhythm in 511 languages (Goedemans and van der Hulst 2009). Some of the StressTyp query results reported here have been taken from Goedemans and van der Hulst (2009) and Goedemans (2010a).[2]

4.2 StressTyp: background and use

4.2.1 Background

Before we embark on our presentation of the arguments supporting the separation claim, let us first briefly review the tool that we use to lend quantitative credibility to these arguments (see also van der Hulst, this volume, chapter 1). StressTyp was developed in the 1990s as a tool to aid researchers in the study of metrical phenomena. First and foremost, it was meant as a key to the literature on this topic. The database contains descriptions of stress systems, taken from descriptive grammars and mostly stated in the form of quasi-parameters which are regarded as theoretically neutral; for a complete overview of the fields contained in a StressTyp record we refer to Goedemans and van der Hulst (2009). These descriptive statements allow students of stress to use StressTyp to generate lists of languages that have certain characteristics in common. In other words, StressTyp is a tool for finding languages that are worth looking into when developing theories of stress. Since various aspects of stress systems have been coded (edge for primary stress, quantity-sensitivity, boundedness, etc.), it is also possible to search for correlations, or narrow down searches to systems that have or lack various combinations of properties. Given the intricate nature of many stress systems, and the fact that second-hand representations of such systems may contain errors, or 'facts' that are colored by interpretations of the author (often guided by theoretical motivations), users of StressTyp are recommended to always consult the primary sources (if not speakers) before making hard-and-fast claims about a certain language. This is basically what we mean when we say that StressTyp is a "key to the literature".

However, as StressTyp grew over the years, from a database containing a random set of about 170 languages to a more balanced sample of over 500 languages, its use as a reliable source for typological studies became more

[2] Goedemans and van der Hulst (2009) contains a detailed description of the history, goals, and record structure of StressTyp. We note here that work is being done on the development of StressTyp2, which will be a merger of StressTyp(1) and the Stress Pattern Database (SPD) constructed by Jeff Heinz (Heinz 2007). We believe that the approach taken in the present chapter underscores the usefulness of databases of this sort. Other useful applications of the StressTyp database can be found in *The World Atlas of Linguistic Structures* (edited by Martin Haspelmath, Matthew Dryer, David Gil, and Bernard Comrie), for which the present authors prepared several maps (Goedemans and van der Hulst 2005a, 2005b, 2005c, 2005d), in Goedemans and van der Hulst (2009), Goedemans (2010a), and van Zanten and Goedemans (2007) and in van der Hulst *et al.* (2010).

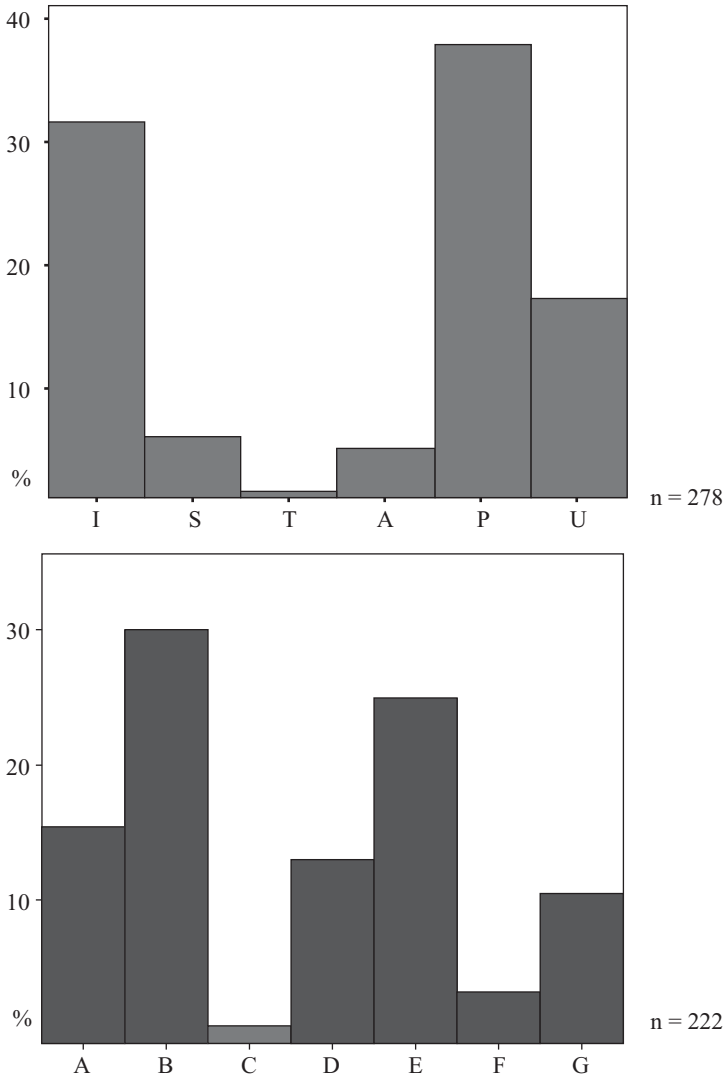
and more apparent. In various recent publications (Goedemans and van der Hulst 2005a, 2005b, 2005c, 2005d, 2009; Goedemans 2010a), we have used StressTyp to generate actual percentages of occurrence for various aspects of stress systems. In many cases, rough assessments had already been proposed in various studies (based on smaller datasets or on the linguist's personal experience and knowledge of the field) but by using StressTyp it was now possible to provide more reliable percentages. Moreover, we have employed StressTyp to provide quantitative support for several theoretical claims. In the second part of this chapter, we will present some examples of the ways in which StressTyp has or can be used to reveal the 'numerical face' of stress phenomena or the theoretical claims regarding them.

Arguably, the comment made above about the accuracy of the descriptions of individual stress systems remains valid. And indeed, when using StressTyp to generate typological backup for the claims one wishes to make, it is imperative to proceed with caution. Many stress systems are rather complicated, and hence difficult to describe in a preset format, no matter how a-theoretical. False positives can easily appear in any list generated from the database. Therefore, all searches need to be compiled carefully, after in-depth study of all the database parameters and their usage. Even then, when dealing with complicated searches (or parameters for which *we* may have devised some unorthodox settings) it is necessary to check the output for languages that do not seem to fit the bill. For any remaining errors the law of 'big numbers' will make it unlikely that reported patterns are inaccurate as such. Given the number of uncertain factors that a descriptive record in a linguistic database depends on, one simply cannot expect to be 100 percent accurate all the time. Fortunately, when a database is large enough, the correct cases will heavily outweigh the false positives (see Goedemans 2010a).[3] With these various caveats in mind, let us consider some examples of how StressTyp has been put to use.

4.2.2 Using the database

In the past we have used StressTyp to visualize the numbers belonging to stress patterns and their properties in various ways. The most direct form is to simply show in a diagram how many languages the database contains for certain basic patterns. In Goedemans (2010a), such diagrams were presented for Quantity Insensitive (QI) and Quantity Sensitive (QS) stress systems. For the former, single stress locations were presented, while for the latter multiple locations were conflated because stress locations vary and pattern types are too numerous to put in one graph. These graphs are reproduced in Figure 4.1.

[3] We refer to de Lacy (this volume) for problems that surround the accuracy of the sources that StressTyp (and typological studies in general) rely on.



A: stress located on one of the leftmost two syllables
B: stress located on one of the rightmost two syllables
C: stress located on left word edge, but not restricted to leftmost two syllables (2 languages only)
D: stress located on right word edge, but not restricted to rightmost two syllables, or stress located on either penult or antepenult (never final)
E: stress may be located on any syllable in the word (unbounded)
F: combination of C or D and E
G: stress location is not predictable/cannot be determined, it is either lexical, completely irregular, or there is no primary stress (all stresses are equally prominent)

Figure 4.1 Stress Types in QI (top) and QS (bottom) languages (taken from Goedemans 2010a)

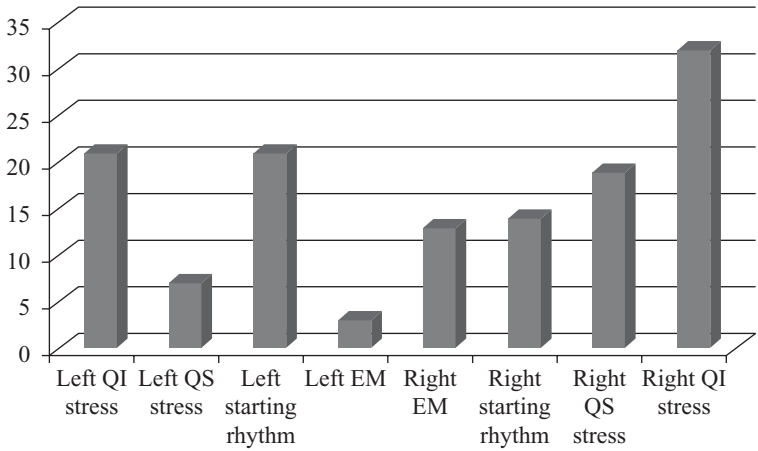


Figure 4.2 Edge preferences in stress systems, relative to total number of languages in StressTyp (i.e. 511 languages)

To get a comprehensive overview of 'edge preferences' in properties of stress systems that are related to edges we might group even more types into single categories. We do that in Figure 4.2, at the same time combining the basic graphs from Figure 4.1 and adding rhythm and Extrametricality edge information. We observe that rhythm fails to adhere to the general preference for right edges in that it quite clearly prefers to start at the left edge.

Alternatively, visualization could take the form of maps. Quite often, just plotting the values of a certain parameter on a map for a good-sized sample of the world's languages will reveal striking areal patterning. This enterprise was undertaken on a large scale by the World Atlas of Language Structures project, in which StressTyp was the source for four chapters (maps) on stress patterns (cf. Goedemans and van der Hulst 2005a, 2005b, 2005c, 2005d). The areal distribution of QI and QS systems was shown there, as well as rhythm types and the various types of Quantity Sensitivity that may feature in stress systems. Later, in Goedemans and van der Hulst (2009) we included a map showing which languages use iambic and which use trochaic feet in the placement of (default) primary stress, while in Goedemans (2010a), a map showing just the division between QI and QS systems was presented. As an illustration of the areal patterning that such maps may reveal, we present two additional maps here. Figure 4.3 shows the distribution of bounded and unbounded systems in the QS realm.

Figure 4.4 may serve as an illustration for chapter 11 in this volume. This map presents the division between iambic and trochaic stress systems in North America.

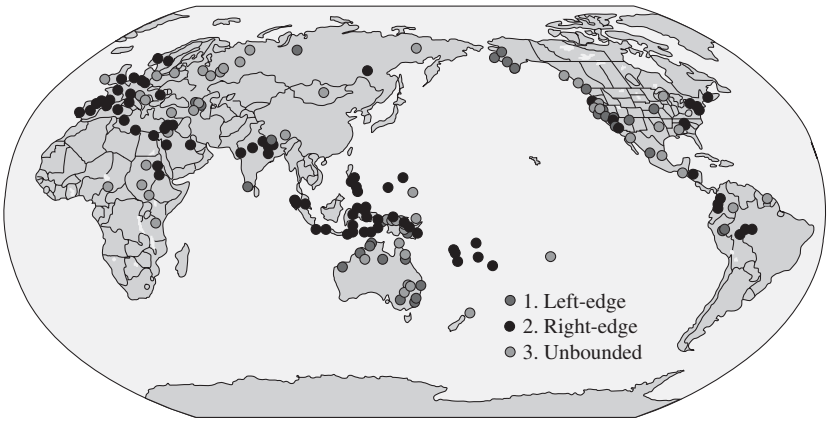


Figure 4.3 QS systems, broken down by boundedness. Map created with the off-line version of WALS. © H-G Bibiko

Figure 4.4 Rhythm types in North America. Map created with the off-line version of WALS. © H-G Bibiko

As a final example of how StressTyp can be used, let us look at a case that is less straightforward than the direct visualizations of parameters and their values presented in Figures 4.1–4.4. We can also use StressTyp to lend support to hypotheses concerning linguistic implications. Such cases were discussed in Goedemans and van der Hulst (2009) and Goedemans (2010a). Let us, for the sake of the argument, test the hypothesis (which turns out to be false) that the location of primary stress in Quantity-Sensitive, bounded systems in any given

Table 4.1 *Preference for stress location in HH domain, broken down by default (LL) stress*

	Stress heavy–heavy	
Stress light–light	Left	Right
Left	23	68
Right	16	6

Table 4.2 *Location of primary stress in HH domain, broken down by domain location*

	Stress heavy–heavy	
Domain	Left	Right
Left	30	7
Right	10	68

language is always the same when the two syllables in the primary stress domain are equal in weight. Thus, whether both syllables are light or both heavy, the hypothesis says that we get stress on either the first or on the last of a sequence 'LL' or 'HH' (L = light syllable; H = heavy syllable). We need four queries to get the answer, one for each combination of domain type and edge (LL = left + HH = left; LL = left + HH = right, etc.). The results are shown in Table 4.1.

So, there are twenty-three cases in which stress is always on the left-hand syllable, whether the domain is LL or HH. However, we can clearly see that our hypothesis is falsified. In fact, the data show that the number of cases that do not conform to the hypothesis is rather high. In no less than sixty-eight cases, stress is on the right-hand syllable in the HH domain, while it is on the left-hand syllable in the LL domain (as opposed to the twenty-three harmonic left−left cases, and only six harmonic right−right cases). Had the hypothesis been 100 percent correct, we should have found no such disharmonic cases. If we look a little further, we realize why it is logical that our hypothesis was falsified. Let us check the values of the Stress heavy−heavy parameter in comparison with the location of the bisyllabic stress domain, shown in Table 4.2.

The real dependency seems to be the one between the location of the stress domain in the word and the preference for which heavy syllables receive stress within that domain: stress likes to land on heavy syllables near the edge, ignoring completely what would happen in case there are no heavy syllables. This edge preference explains why the hypothesis we tested turned out to be false.

Since StressTyp contains quite a few fields, one could easily provide figures for many more parameter combinations. In the next section we will present the results of a set of queries that were performed to provide support to the theoretical claim mentioned in section 4.1, namely that primary stress and rhythm are independent phenomena that should not be unified within a single stress algorithm.

4.3 Two views on the relation between primary stress and non-primary stress(es)

As an example of the unified approach, let us briefly review how stress patterns are derived in standard metrical theory (Liberman and Prince 1977; see also van der Hulst, this volume, chapter 1). First, syllables of words are organized into headed feet. Second, primary stress is derived by organizing the feet into a *word structure* in which one foot is the head. The head of the head foot expresses primary stress. In this view, then, rhythmic beats are assigned *first*, while primary stress is regarded as the promotion of one of these rhythmic beats. Metrical theory, clearly, views primary stress as being dependent on the factors that determine the rhythmic structure of the word. Rhythm and primary word stress are represented in terms of one structure, albeit that in this structure there are two levels which directly correspond to this distinction.

In van der Hulst (1984), and subsequently in a number of other articles (see van der Hulst 1996, 2009, 2010, 2012, this volume, chapter 11), a different approach is developed. Rather than building primary stress on the basis of rhythm, it is suggested that we reverse the relationship and assign an accent first, making the assignment of rhythmic beats a truly secondary matter. A similar claim has been made in other studies, sometimes only with reference to specific systems (Odden 1979;[4] Harms 1981; Roca 1986; Goldsmith 1990; Hurch 1996; Bailey 1995). Harms (1981) called this method a 'backward approach'. McGarrity (2003), adopting an OT approach, offers support for the idea to separate primary and non-primary or rhythmic stress by discussing numerous cases in which the constraints bearing on both differ in one way or another (cf. below).

We regard the primary stress as a correlate of accent (in terms of phonetic properties such as duration, hyperarticulation, etc.) which may or may not be accompanied by overall word rhythm in which the accented syllable is the strongest rhythmic beat. A language can have an accentual system without

[4] Odden clearly demonstrates that the account of stress in Chomsky and Halle (1968) was also unified, and, in this sense, metrical theory continues that view. He presents arguments to separate the treatment of primary stress and non-primary stress that are similar to the ones discussed in this chapter. Odden concludes that both aspects of word prominence should perhaps always be separated, even in cases where, perhaps accidentally, the two could be collapsed into one rule. Again, that is also the position taken here.

having stress, in which case the accent may interact with some other aspects of words, such as the tonal system (a tone-accent language) or a specific pitch pattern (a pitch-accent language). A language may also have a stress module that is not 'fed' by an accentual module, in which case stress is fully predictable. We assume that as soon as a language allows for exceptional stress locations, *all* stress locations are dependent on an accentual algorithm. The separation theory says that stress in stress-accent languages is separated from and prior to rhythm. The relationship between non-accentual (i.e. automatic) stress[5] and rhythm remains to be established. For a detailed discussion of these matters, we refer to van der Hulst (2012, this volume, chapter 1, chapter 11, in prep.).

The crucial claim of the accent approach suggested here is that primary stress (or rather accent) assignment and rhythm, perhaps more often than not, simply cannot be captured in terms of a single algorithm which essentially sees the primary stress as a promoted rhythmic beat. This suggests that, in these cases, there will have to be two independent algorithms. The fact that primary stress assignment (in the form of accent assignment) in some sense *precedes* rhythm assignment is, in retrospect, a separate issue. It is one way of explaining that accent and rhythm, while captured in separate algorithms, display a one-way dependency that precludes accent being dependent on rhythm.[6] This dependency takes two forms (see van der Hulst, this volume, chapter 11). On the one hand, the most common form of rhythm appears to be one that starts at the location of the accent and moves to the other edge from there; below we call this *echo rhythm*; cf. Garde's 1968 apt phrase 'echo accent' for rhythmic beats. Another possibility, identified in van der Hulst (1984), in which rhythm comes from the opposite edge, is called a *polar rhythm*. Systems with polar rhythm have been called 'polar', 'dual', and 'directional'. Van der Hulst (this volume, chapter 11) and Moskal (submitted) propose that polar rhythm results from two steps, one assigning a beat to the syllable that lies at the edge opposite to the primary stress, and a second step in which this polar beat itself triggers a rhythmic wave moving away from it. Of course, by recognizing the polar beat as an independent ingredient of word prosodic patterns, we also need to reckon with the possibility of rhythm moving away from the primary stress toward the polar beat.[7]

Polar beats are captured under the notion Edge Prominence, as developed in Moskal (submitted). An interesting possibility is to hold this mechanism

[5] It should be noted that fully automatic word stress is often very elusive, sources being uncertain as to its precise location or phonetic properties; see Goedemans and van Zanten (2007) on the case of Indonesian.

[6] While saying this we are of course aware of what we have called 'count systems', in which this type of dependency seems to hold; see van der Hulst (1997, 2012, this volume, chapter 11) for a discussion of these kinds of system.

[7] Liberman and Prince (1977) introduce a rule of Initial Beat Addition that accounts for the initial secondary stress, and which arguably is somewhat like the Edge Prominence rule. Note that this rule in their account follows rather than precedes the assignment of rhythmic alternation, whereas, as stated here, Edge Prominence precedes rhythm.

responsible for 'primary stress' in non-accentual stress languages. Like rhythmic alternation, we would assume that Edge Prominence is an automatic process and we would locate both mechanisms at the post-lexical level, accent assignment being a lexical mechanism. The dependencies between accent on the one hand and Edge Prominence and rhythmic alternation on the other hand fall out naturally if accent assignment comes first in a derivational sense, which is naturally expressed by locating these phenomena at the lexical and post-lexical level, respectively. We refer to van der Hulst (this volume, chapter 11) for a detailed discussion of these matters.

In a non-derivational model, this relationship would have to be accounted for by simply *stipulating* the one-way dependency that holds between the accent and the rhythmic plane (assuming that Edge Prominence *and* rhythmic alternation are both located in this plane). Note that, here, the notion of 'dependency' captures what is expressed in terms of ranking in OT (cf. van der Hulst 2011). For those working within an overall dependency approach, it comes as no surprise that dependency relations hold everywhere, not just between units within a plane, but also between planes. In that sense, it could be said that a non-derivational approach appeals to a notion (dependency) that is available to grammars anyway.

In this chapter, we will not focus on these derivational issues nor on details of the accent and rhythm representations. Instead, taking Edge Prominence and rhythmic alternation to be included in the notion of rhythm, we will focus on the notion that accent and rhythm often have different properties, which prevents the unification that metrical theory was trying to capture.

4.4 Bottom-up and top-down parsing

The initial (and, in retrospect, perhaps not the crucial) motivation for the separation hypothesis (in van der Hulst 1984) was that primary stress in most systems seems to fall on the foot that is assigned first in the classical metrical account.[8] Formally, this means that in systems that assign feet from left to right, the word tree would almost always be left-headed, while it would be right-headed in right-to-left systems. This pattern would be non-surprising if primary stress is *universally* assigned first, with rhythm typically 'echoing' (or rippling away). However, although in the majority of systems the edge of iteration and the edge of primary stress coincide, it is nonetheless the case that in some systems the opposite situation obtains. If, for example, primary stress is initial in words consisting of an even number of syllables, while it lies on the second syllable when the number is odd, it would seem that the syllables have to be parsed into left-headed feet (from right to left) first, so that after that the leftmost foot can be selected as the word head. Systems of this kind were called *count systems* in

[8] This correlation was independently noted in Hammond (1985).

van der Hulst (1996, 1997). Crucially, in such systems, footing has to precede primary stress assignment because it is not possible to locate accent locally at the left edge of the word. We can find this pattern in Malakmalak, discussed in Goldsmith (1990: 173–7).

Quoting van der Hulst (1984), Hayes (1995) refers to the accent first mode as 'top-down parsing', suggesting that the word tree is built first, while foot structure is 'tucked in' later.[9] He then refers to Tiberian Hebrew, Cahuilla, Tümpisa Shoshone, Czech, Mayi, Old English, Cayuvava, and Estonian as other cases for which he himself has adopted a 'primary stress first' analysis. We will not discuss his specific reasons for coming to this conclusion here, but at this point only draw attention to the fact that Hayes recognizes the need for a primary stress first approach. Referring to cases such as Malakmalak for which a primary stress first approach would yield "an extremely complex primary stress rule", he concludes that for these languages "the bottom-up analysis is far more straightforward". Hayes (1995: 117) asserts that for "the majority of languages, it is apparently impossible to determine the answer, because primary stress usually falls on the point of origin of the alternating count . . . For concreteness, I express stress in bottom-up fashion here except where the facts require otherwise." Thus, Hayes decides that the 'rhythm first' approach is the "default mode, while the 'primary stress first' systems require a treatment that deviates from the default method". Here, following our earlier work, we adopt the opposite view by taking the primary stress first mode as the default, which entails that count systems need a special treatment. For a discussion of how these count systems can be analyzed, see van der Hulst (2012).[10,11]

Although we do not want to claim that frequency differences can be used as proof to decide on competing theories, let us consult StressTyp with respect

[9] Apparent top-down systems have been used in the early OT literature (Prince and Smolensky 1993) as an argument against the possibility of accounting for all stress systems derivationally. If one assumes that metrical structures are generated randomly (by the so-called 'generator'), the top-down 'syndrome' would exist when constraints bearing on the word structure outrank constraints bearing on foot structure. For example, in a system where rhythm is weight-sensitive, while at the same time primary stress is fixed on the initial syllable, irrespective of its weight, a constraint which demands that the head of the word is 'left-aligned' would outrank the constraint expressing weight-sensitivity.

[10] It is possible that what is called 'primary stress' in such a language is an intonational effect. It would not be reasonable to suggest that such systems result from applying Edge Prominence *after* rhythm, since the discussion of polar systems suggests that EP applies *before* rhythm. Count systems can sometimes be analyzed as *transitional systems*, which in a temporal or geographical sense lie in-between systems that have primary stress on opposite edges. See Goedemans (2010b) for this point with reference to count systems in Australia.

[11] Al-Mohanna (2007) applies the idea of separating primary stress and rhythm in an OT analysis of count systems that lack phonetic evidence for the iterative foot structure that is supposedly necessary to compute the location of primary accent. In earlier accounts (cf. Halle and Vergnaud 1987) such systems have been analyzed in terms of 'line conflation', a mechanism that perhaps casts doubt on the claim that count systems crucially motivate the necessity of a rhythm-first method. See Crowhurst (2004) for another OT attempt at systems of this sort.

Table 4.3 *Results of Query 1 (Types of rhythm)*

Systems with rhythm

non-count	echo rhythm	126	70%
	polar rhythm	39[a]	22%
count		15	8%

[a] This number includes cases with polar secondary stress with and without further alternating rhythm; see Table 4.5.

to the difference between count systems and non-count systems. We give both absolute numbers and percentages in Table 4.3.

These results confirm that in 22 percent of the cases, primary stress is not dependent on rhythm, since rhythm comes from the other side. (This percentage would be higher if we were to include other reasons for why primary stress should precede rhythm.) More important is the asymmetry between echo rhythm systems and count systems. If rhythm always precedes primary stress assignment, there is no explanation for the fact that count systems are so low in number. The view that rhythm follows accent assignment *explains* the high frequency of the echo cases because the simplest way to respect accent is to anchor the rhythmic melody to it and 'spread it out' from there. In a standard metrical account where rhythm precedes the selection of primary stress, there is no *dependency* between the edge at which rhythm starts and the edge for primary stress. The fact that there are many more echo systems than count systems suggests, however, that such a dependency is likely to be real and this is precisely what the separation theory predicts. The theory simply rules out the dependency in the other direction (which raises the question of how count systems should be dealt with), but perhaps it allows another dependency in which rhythm responds to a polar stress, while still respecting the stress corresponding to the lexical accent in not producing a clash in its spread towards the stress-accent.

In the next section we will discuss some more specific reasons for rejecting the metrical bottom-up approach as the default mode. But first, we will discuss one other more general argument.

After having presented many case studies on languages with stress, Hayes (1995: 116–17) states:

> In all the analyses given so far, bracketed grids have been constructed from the bottom up . . . Van der Hulst 1984, 178–82, suggested a less obvious procedure: assign the primary stress first . . . Which of these two options (bottom up vs. top down) is correct? The answer appears to be that it depends on the language in question. For example, in Swedish . . . it is clear that primary stress must be assigned before secondary stress, since primary stress assignment is lexical, secondary post-lexical.

We would like to strengthen this argument by pointing out that it is highly typical for primary stress and rhythm to display the kinds of property that are generally associated with lexical and post-lexical processes. In fact, whereas the location of primary stress may, in principle, be post-lexical in those cases in which it is absolutely fully automatic, we believe that this is not at all typical. Even in languages that are said to have predictable primary stress more often than not descriptions will refer to *exceptions*. However, it would seem that non-primary stresses (polar beats, alternating rhythm) *are* typically fully automatic. In general, all the usual criteria for distinguishing between grammatical ('lexical') and utterance ('post-lexical') rules seem to square with the differences between locating accent (for primary stress) and secondary rhythmic beats. A consequence of being lexical is that accent can be sensitive to *lexical exceptions* (however these are marked), specific *word classes*, *morphological structure*, and *stratal differences* (classes of words with different origins, such as being imported from another language). As said, it is indeed very common for primary stress to have exceptions. An extreme case of lexical exceptionality occurs in so-called 'lexical accent systems', in which most individual morphemes must be lexically marked for accent (Revithiadou 1999). We also see that primary stress can be sensitive to a difference between e.g. nouns and verbs (which might be the case in Rumanian; cf. McGarrity 2003, and in fact in English, where we see a difference between nouns and verbs/adjectives). StressTyp reports more such cases (like Ghodoberi, described in Kodzasov 1999). Finally, stress location can be sensitive to morphological structure in the sense that its location is determined with reference to the 'stem' rather than the whole 'word' (however these notions are defined). Another kind of morphological determination is found when specific sets of suffixes have specific accentual properties (such as being accented, or 'pre-accenting').

The strongest claim, following from its post-lexical status, would be that rhythm can *not* be sensitive to any of these factors. This claim strikes us as generally correct. Obviously, various kinds of apparent counterexamples need to be addressed, including claims that different word classes have different rhythmic patterns and the need for specifying unpredictable rhythmic beats; we refer to van der Hulst (in prep.) for such matters.[12]

As for rhythm, it would seem that the usual criteria for post-lexical status certainly apply. Details of rhythmical structure can be dependent on speech rate

[12] Chuck Cairns pointed out to us that the proposed separation of accent and rhythm, the former being lexical, the latter implementational, predicts that morphological processes are more likely to be dependent on accent than on rhythm. An interesting challenge to this prediction (brought to our attention by Carlos Gussenhoven) is that the allomorphy of the diminutive suffix in Dutch is sensitive to the presence of a stem-final beat, whether accentual or rhythmic. See van der Hulst (2012, in prep.) for a discussion of this and other cases.

and formality (see Hualde and Nadeu, this volume) as well as on larger phrasal context (see Roca 1986).

Concluding, both the fact that languages in which the location of primary stress is crucially based on a prior layer of footing (i.e. count systems) are rare, and the fact that rhythmic stress has all the properties of a post-lexical process, suggest to us that a model in which primary stress (i.e. accent) is assigned prior to non-primary stress, such that the former is lexical while the latter is post-lexical, is superior to the standard metrical bottom-up approach. Finally, we might ask whether this approach explains why an echo rhythm (in which accent is the direct anchor for rhythm) is more likely than a polar rhythm. To explain this we would point to the fact that accents are more robust anchor points for rhythm which is subject to post-lexical variabilities.

4.5 Additional arguments for AF

Once the accent first approach had been proposed, additional motivation for it emerged. From the viewpoint of metrical theory, there are several situations in which a unified algorithm simply cannot account for both primary and non-primary stress.

In the following survey of arguments, the reader must bear in mind that we state the differences between primary stress and non-primary stress *in terms of standard metrical terminology* to make the point that *within this approach* different algorithms would be required. Here, we will not focus on how we would analyze all the systems mentioned in terms of the AF theory (for in-depth discussion see van der Hulst 2012, this volume, chapter 11, in prep.).

4.5.1 Accent and rhythm can differ in terms of Extrametricality

In metrical theory, Extrametricality is a device that accounts for the fact that a peripheral syllable (usually the one on the right edge) is unavailable for 'stress'. If accent and rhythm are separated, we expect that Extrametricality could apply to only one of these or even to both in different ways (given that different entities such as syllable or final segments can be extrametrical). It would seem that cases in which accent is subject to an Extrametricality requirement, while rhythm is not, certainly exist. McGarrity (2003) mentions Khalkha as a case in point. Here accent lies on the rightmost *non-final* heavy syllable. Yet all heavy syllables, including one that is final, are said to have 'secondary stress' (see Table 4.4).

Table 4.4 *Results of Query 2 (Differences in Extrametricality)*

Extrametricality	
EM (yes) for primary stress and EM (no) for rhythm	14 languages

Munsee and Unami (Goddard 1982) are prototypical cases. Both have Extrametricality (EM) on the right side of the word for primary stress, but not for rhythm.

4.5.2 Accent and rhythm can differ in choice of word edge

As discussed in section 4.3, rhythm can either echo away from the primary stress location or come from the other side. The second case, polar rhythm, provides a further argument for separating primary stress and rhythm. Such a situation forms an embarrassment for the standard theory because, clearly, two separate algorithms are necessary. In this case, too, it is of course possible to have two phases of foot assignment in the standard approach. English qualifies as a language with right-edge primary stress and left-to-right polar rhythm. It is possible to analyze this with a first foot layer (right to left) of which we erase all but the rightmost foot and then a second assignment of foot structure, now from left to right.[13] Or one might suggest that a foot is assigned non-iteratively at the right edge, followed by an iterative application from left to right. One would expect to also find cases in which accent is placed at the left edge, while rhythm comes from the right, a situation that has indeed been suggested for Garawa, for which a two-step analysis is also possible. The point is, of course, that such derivations (designed to deal with primary stress and rhythm separately) are not expected, given the core design of standard metrical theory.

The results of Query 1 (Table 4.3) show that polar systems are fairly common. We also find the same kind of duality in languages that do not have alternating rhythm and yet have polar secondary stress on the edge that lies opposite to the primary stress. Thus the group with polar non-primary stress has two subclasses, those with alternating rhythm stresses and those with a single non-primary stress (see Table 4.5).

We conclude that for a significant number of languages it is not just the case that we can account for primary stress without assigning rhythm first. Rather, in

[13] This comes close to Halle and Vergnaud's (1987) account of English, a language with right-edge primary stress displaying polar rhythm, in that the initial syllable will typically be rhythmically strong (as long as primary accent is not on the second syllable).

Table 4.5 *Results of Query 3 (Differences in edge selection)*

Starting edge for direction of footing

Polar rhythm	Iterative	15
	Non-iterative	24
Total		39

thirty-nine languages, assigning rhythm first will make it impossible to derive primary stress.

4.5.3 Accent and rhythm can differ in weight-sensitivity

We now turn to four queries that bear on the type of foot that is needed for primary stress and rhythm. Cross-linguistically, feet can differ in weight-sensitivity, 'arity' (binary, ternary), headedness (left, right), and boundedness. We will see that for all four parameters, the required foot type can differ. We start, in this section, with weight-sensitivity.

The AF theory predicts that the weight criteria for primary stress and rhythm may differ from each other. After all, in the AF theory we have two distinct algorithms, one for accent and the other one for rhythmic beats. Nothing, then, prevents one from being Quantity Sensitive, while the other is not, or both from being Quantity Sensitive in different ways. Clearly, if such discrepancies exist, they are *un*expected from the viewpoint of the standard metrical account, which then needs to be amended by allowing two different phases of foot assignment, the one that accounts for primary stress either being non-iterative or seeing most of its feet erased. An example of such a discrepancy between accent and rhythm occurs in Tübatulabal, which assigns primary stress to the final syllable, irrespective of its weight. At the same time, the distribution of rhythm appears to be sensitive to syllable weight (Hayes 1995). The same point can be made for Finnish and Proto-Germanic (i.e. primary accent is QI, while rhythm is QS). One might suspect that the reverse situation (primary accent is QS, rhythm is QI) is also possible, and one might plausibly argue that this, in fact, applies to languages such as English and Dutch. Third, there are also cases like Meso Grande Diegueño (Couro and Hutcheson 1973) in which both accent and rhythm are weight-sensitive in different ways, i.e. in which the weight criteria for accent and rhythm differ. The results in Table 4.6 clearly show that it is not at all uncommon for weight-sensitivity to differ for accent and rhythm.

Table 4.6 *Results of Query 4 (Differences in weight-sensitivity)*

Weight-sensitivity

Accent	*Rhythm*	
weight-sensitive	weight-insensitive	31 languages
weight-insensitive	weight-sensitive	17 languages
weight-sensitive A	weight-sensitive B	8 languages
weight-insensitive	weight-insensitive	102 languages
weight-sensitive	weight-sensitive	52 languages

Table 4.7 *Results of Query 5 (Differences in arity)*

Binary and ternary feet

Ternary rhythm and a binary primary accent foot:	6
Antepenultimate (QI) primary stress and binary rhythm:	3
Antepenultimate (QS) primary stress and binary rhythm:	9
Antepenultimate stress with binary rhythm as common exception:	3
Total	21

4.5.4 Accent and rhythm can differ in 'arity'

In this section we consider cases in which the primary accent foot is binary, whereas rhythmic feet establish a ternary pattern, as in Chugach (Hayes 1995: 333). If there are languages that have antepenultimate primary stress combined with binary rhythm, one could construe this as the opposite situation. We did not find cases with a ternary foot for primary stress and ternary rhythm (see Table 4.7), but we see no reason why, in principle, a language showing this pattern could not be found.

4.5.5 Accent and rhythm can differ in foot headedness

A fifth motivation involves languages in which foot types necessary for primary stress and rhythm differ in headedness. From the viewpoint of classical metrical theory such systems again form an anomaly. If foot types for accent and rhythm differ in this way, again both aspects cannot be captured in a single metrical recipe. It is always possible to propose two algorithms, one non-iterative (for primary accent) and one iterative (for rhythm), but this,

Table 4.8 *Results of Query 6 (Differences in foot types)*

Left-headed (trochaic) or right-headed (iambic) feet

Languages with foot type specification for primary stress and rhythm	163
Primary stress trochaic	138
Rhythm type trochaic	133
Rhythm type iambic	2
Rhythm type both iambic and trochaic	3
Primary stress iambic	25
Rhythm type iambic	15
Rhythm type trochaic	9
Rhythm type both iambic and trochaic	1

in itself, suggests that a separation of accent and rhythm is called for (see Table 4.8).

All in all, 7 percent of the languages in StressTyp show a mismatch of this type (disregarding the 'both iambic and trochaic' cases in the count). What strikes us further is the huge ratio difference between mismatches in which primary stress is trochaic and those in which it is iambic. Relatively, there are far more languages preferring trochaic feet while primary stress is iambic than there are languages preferring iambic feet while primary stress is trochaic. This, of course, reflects the general preference for trochaic feet in all languages (see Goedemans and van der Hulst 2005d).

4.5.6 Accent and rhythm can differ in boundedness

A fourth property of feet is their size, with the options of being bounded or unbounded (see Table 4.9). We find a difference of this sort when primary stress is fixed on, let us say, the first syllable, while in the remainder of the word only heavy syllables receive a 'rhythmic' beat, as in the Waalubal dialect of the Australian language Bandjalang (Crowley 1978). In metrical theory, such systems can be analyzed in terms of unbounded feet, but it is also possible to interpret this case as combining bounded feet (for primary accent) and unbounded feet (to mark the rhythmic beats).[14]

Going back to the difference in edge selection, we note that non-iterative polar systems *could* also be analyzed as combining bounded feet (for primary stress) and unbounded feet for the single polar secondary stress. Within standard

[14] In fact, a language of this type would appear to have no rhythm at all, just syllable weight; all heavy syllables are marked on line one of the grid.

Table 4.9 *Results of Query 7 (Differences in boundedness)*[a]

Bounded and unbounded feet

Primary stress bounded, rhythm QS unbounded	12
For comparison	
Primary stress bounded, rhythm QS bounded	38
Primary stress unbounded, rhythm QS unbounded	4

[a] The 'Primary stress unbounded – Rhythm bounded' type also exists and is exemplified by Yidin^{y} (Dixon 1977), which places primary stress on the first heavy or the first and secondary stresses on alternate syllables before and after the primary stress. This type also supports the separation of primary stress and rhythm. It is not represented in Table 4.9 because we did not want to confound the picture by introducing QI rhythm. Descriptions for the handful of languages that seemed to have unbounded primary stress and QS bounded rhythm, a type that should have been in Table 4.9, were too unclear on this point to allow for a reliable count.

metrical theory this would be a possible analysis, which would require different treatments for primary and non-primary stress.

4.5.7 Other problems for classical metrical theory

Our next two queries were not designed to reveal differences between primary stress and non-primary stress. Rather, the next two arguments in favor of AF that we will discuss rest on the claim that metrical theory cannot provide an adequate account of all instances of primary stress. In both cases we consider QS systems. We first look at *bounded* QS systems in order to show that the variety of systems attested in that category cannot be covered by any foot theory that we have seen, neither the original standard symmetrical inventory (proposed in Vergnaud and Halle 1978), nor the asymmetrical revised theory in Hayes (1995). Then we turn to *unbounded systems* which, by Hayes's own admission, do not fall within the scope of metrical theory, although this claim is not shared in all versions of metrical theory (see Halle and Vergnaud 1987 or Idsardi 1992).

4.5.7.1 Not enough bounded foot types

In some cases, the standard theory simply cannot handle the location of primary accent in terms of its foot inventory, no matter what variant of foot theory one adopts, at least not without postulating additional 'movement rules'. These problems always seem to involve primary stress location. To illustrate the problem, let us consider bounded weight-sensitive systems, on both the left

and right edge. (1) demonstrates that four types of system at both edges are attested. The last column in (1) indicates how these systems could be analyzed and shows that, in several cases, movement rules are required:

(1) *Weight-sensitivity in bounded systems*

	Right edge				
I	X	X	x	x	**Rotuman**
	(h l)]	l(h)]	h(h)]	(l l)]	*WS trochee*
II	X	X	x	x	**Yapese**
	(h)l]	(l h)]	h(h)]	(l l)]	*WS iamb*
					QD trochee[15]
					WI iamb + R: h<l][16]
					Mor. iamb[17]
III	X	X	x<	x	
	x)	x)	x x)	x)	**Aklan**
	(h) l]	(l h)]	(h)(h)]	(l l)]	*WS iamb + R: h<h]*
					WI iamb + R: h<σ]
IV	X	x>	x	x	**Awadhi**
	H l)]	(l h)]	(h h)]	(l l)]	*WI trochee + R: l>h]*
					Mor. trochee
	Left-edge				
I	X	X	x	x	**Ossetic**
	[(h)l	[(l h)	[(h) h	[(l l)	*WS iamb*
II	X	X	x	x	**Malayalam**
	[(h l)	[l(h)	[(h)h	[(l l)	*WS trochee*
					QD-trochee
					WI trochee + R [l>h
					Mor. trochee
III	x	x	>x	x	
	(x	(x	(x x	(x	**Capanahua**
	[(h l)	[l(h)	[(h)(h)	[(l l)	*WS trochee + R [h>h*
					WI trochee + R [σ>h
IV	< x	x	x	x	
	[(h l)	[(l h)	[(h h)	[(l l)	**Archi**
					WI iamb + R [h<l
					Mor. iamb

[15] Hayes, originally, treated Yapese with the use of a special foot type, the obligatory-branching trochaic feet (Hammond 1986), called 'quantity-determined' (QD) in van der Hulst (1984), which was originally proposed in Vergnaud and Halle (1978). Here the head *must* be heavy.

[16] This notation means: we need a rule that shifts accent from a final light syllable to a penultimate heavy syllable.

[17] Strictly moraic feet are proposed in Kager (1993).

Table 4.10 *Results of Query 8 (Bounded weight-sensitive systems on either edge)*

Bounded weight-sensitive feet

Left edge		Right edge	
Type Ossetic	11	Type Rotuman	62
Type Malayalam	13	Type Yapese	5
Type Capanahua	6	Type Aklan	5
Type Archi	1	Type Awadhi	10
Total	31		82

In each case the first analysis is the standard metrical analysis.[18] There is support for each of these eight cases, albeit sparse for some of them (see Table 4.10).

Clearly, a full account of possible accent locations falls outside the reach of the foot typologies that have been developed in metrical theory. AF theory constructs a separate module for accent location that can handle these complexities (see van der Hulst 2009, 2012). Rhythmic stresses do not require such complexities and, in this case, metrical foot typologies overshoot what is necessary. Once accents have been located, rhythm can be accounted for in a quite simple fashion, perhaps needing only a trochaic grid algorithm (see van der Hulst, this volume, chapter 11). Accent seems to be symmetrical, allowing left and right options within the accentual domain. Rhythm, on the other hand, is asymmetrical, strongly favoring or perhaps only allowing a trochaic pattern. In conclusion, the holistic metrical toolkit is underqualified to deal with accent and overqualified to deal with rhythm.

4.5.7.2 Unbounded systems

Additional motivation for AF comes from the treatment of so-called 'unbounded systems'. Various approaches to unbounded systems, employing bounded or unbounded feet, have been proposed over the years. Hayes (1995: 33) eventually concludes that such systems *are* non-metrical because there is no need for rhythmic foot structure in order to derive the location of primary stress. Nonetheless, such systems require an algorithm to derive primary stress and in some cases an acknowledgment that all heavy syllables are prominent. Hayes remarks that "because the facts in this area are quite simple and fill out

[18] One can of course adhere to versions that would disallow some of these analyses, but it is obviously not in favor of metrical theory that so many alternatives are, in principle, available.

Table 4.11 *Results of Query 9 (Unbounded systems)*

Unbounded systems

F/F: Stress the first heavy syllable, or the first syllable if there are no heavy ones	22
F/L: Stress the first heavy syllable, or the last syllable if there are no heavy ones	8
L/F: Stress the last heavy syllable, or the first syllable if there are no heavy ones	11
L/L: Stress the last heavy syllable, or the last syllable if there are no heavy ones	5
LEX: Stress is lexically determined and can occur anywhere in the word	21
Unique: Stress may occur anywhere in the word, governed by intricate rules	15
Total	82

all the logical possibilities it is hard to develop a theory that goes much beyond just describing the facts". This, in a sense, is disappointing because the original theory, at least, managed to express a kind of parallelism between bounded and unbounded systems (see Vergnaud and Halle 1978). The two differed in foot size, but otherwise fell into the same types (see Table 4.11).

In AF theory the four types of unbounded system parallel the four types of bounded system that we find on each edge (see Query 8, Table 4.10), so in this sense AF recaptures an original insight of standard metrical theory that got lost along the way. The four logical possibilities can be derived in terms of two rules that van der Hulst (2012) called 'Select' and 'Default', both of which have two values (Left, Right). In (2) bold sigmas represent heavy syllables. In weight-sensitive systems each heavy syllable gets an accent. The stress domain can be bounded (bisyllabic) or unbounded. If this domain contains only one heavy syllable, there is nothing further to say. If there is more than one heavy syllable Select picks out the accent that 'wins', and if there are no heavy syllables Default assigns an accent. This, as shown in van der Hulst (2012), is all the apparatus we need to derive four types of bounded system (both for the left and right side of the word) and four unbounded systems:

(2) *Bounded and unbounded systems*

Weight-sensitive	Bounded (right/left edge)				Unbounded	
Sel(R);Def(R)	x (**σ**σ)	x (σ**σ**)	~~x~~ x (**σ**σ)	x (σσ)	~~x~~ x (σσ**σ**σ**σ**σσ)	x (σσσσσσ)
Sel(L);Def(R)	x (**σ**σ)	x (σ**σ**)	x ~~x~~ (**σ**σ)	x (σσ)	x ~~x~~ (σσ**σ**σ**σ**σσ)	x (σσσσσσ)
Sel(L);Def(L)	x (**σ**σ)	x (σ**σ**)	x ~~x~~ (**σ**σ)	x (σσ)	x ~~x~~ (σσ**σ**σ**σ**σσ)	x (σσσσσσ)
Sel(R);Def(L)	x (**σ**σ)	x (σ**σ**)	~~x~~ x (**σ**σ)	x (σσ)	~~x~~ x (σσ**σ**σ**σ**σσ)	x (σσσσσσ)

A theory, such as the one offered in van der Hulst (2012), which rejects the idea that primary stress is based on bounded feet (as defended in Hayes 1995) has no problem generalizing over bounded and unbounded systems.

4.6 Conclusions

In this chapter, it was our aim to provide some examples of how a database such as StressTyp can be used. We provided some straightforward examples and then proceeded to a more complex application in which our aim was to use data from StressTyp to investigate to what extent primary stress and non-primary stress can *not* be unified in one algorithm. What got us started on this pursuit is the huge difference in the number of systems in which rhythm can be seen as responding to primary stress being there first (whether echo or polar), and systems in which rhythm must crucially be established first. This was supported by our first query:

Q1: echo/polar systems versus count systems

Thus having established the grounds for a separation theory, we performed six queries which directly reveal cases in which there cannot be a single foot algorithm for primary stress and non-primary stress. We essentially established that with respect to all so-called 'metrical' parameters such differences can be found:

Queries that show difference between primary and non-primary stress

Q2: differences in Extrametricality

Q3: differences in edge selection

Q4: differences in weight-sensitivity

Q5: differences in arity

Q6: differences in foot types

Q7: differences in boundedness

Finally, we supported the now well-established AF theory by performing two queries that reveal cases of weight-sensitive stress in which metrical theory cannot deliver an adequate account of primary stress locations:

Q8: bounded systems

Q9: unbounded systems

Our queries pretty much exhaust the list of parameters that have been proposed in the metrical literature, starting with Vergnaud and Halle's (1978) seminal

paper. We suspect that if additional parameters have been proposed, it would always be possible to again locate systems in which accent and rhythm require different settings.

An anonymous reviewer expresses the view that our results are eminently descriptive, as opposed to aimed at explanations. In addition, the reviewer observes (correctly, we believe) that there are properties that cut across primary and secondary stresses, pointing to the fact that in English the two swap without any further recalculation in pairs like *ábsolùte/àbsolútely*. Also, primary stresses can be preserved as secondary stresses in word formation, as in *medícinal/medìcinálity*. Such correlates, it is claimed, are said to be mysterious if both types of stress are regarded as unrelated phenomena. A further remark, bearing on what we have called Edge Prominence, regards the fact that patterns of secondary stress assignment are weight-sensitive, as in *Monòngahéla* (**Mònongahéla*), just as the pattern of primary assignment is, e.g. agénda (**ágenda*), again suggesting a close relationship.

First, we would like to claim that the proposed separation theory explains the observed discrepancies between primary and non-primary stress in the sense that this theory leads one to expect that such discrepancies are going to occur regularly. Cases in which the location for primary stress 'shifts' (*ábsolùte/àbsolútely*) are in our view possible because both the primary stress (based on accent) and secondary stress (based on Edge Prominence) can function as anchor points for intonational pitch accents. For a discussion of cases like *medícinal/medìcinálity*, which involve so-called 'cyclic effects', we refer to van der Hulst (this volume, chapter 1). Finally, it is of course true that both accent and rhythm (including Edge Prominence) can be weight-sensitive. But, as we have seen, there are numerous cases where the two differ in weight-sensitivity. It is simply a logical possibility that both can be sensitive to weight in the same way (although it remains to be established that in English both are in fact sensitive to *the same* weight properties).

We conclude that there is good empirical support for our decision to separate the treatment of primary stress (accent) and rhythm. In this chapter, we have not proposed specific theories for accent and rhythm. For the latter we refer to van der Hulst (this volume, chapter 11) and for the former to van der Hulst (2012). We do not doubt that especially bounded accent location is perhaps grounded in rhythmic principles or tendencies, or indeed in functional factors that relate to edge demarcation, but this does not mean that, synchronically, accent location is rhythm-based. Gordon (this volume) in fact suggests that penultimate or second syllable stress may have nothing to do with foot structure, but rather finds its rationale in the avoidance of tonal crowding when complex intonational tones associate to the edges of words. However, no matter what the historical causes are, when natural phonetic or functional factors are conventionalized (or 'grammaticalized') they get divorced from their phonetic or functional bases and can thus acquire properties that are different from that which they

are grounded in, either simply because they are now independent and free to develop in their own way or because the computational machinery that is available to the mental grammar stipulates certain kinds or properties that are not grounded in phonetics or functional factors.

Relevant websites

StressTyp: www.unileiden.net/StressTyp/
StressTyp2: http://st2.ullet.net
Stress Pattern Database: http://phonology.cogsci.udel.edu/dbs/stress/
Stress System Database: www.cf.ac.uk/psych/ssd/

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Part II

The description, selection, and use of stress data

5 Evaluating evidence for stress systems

Paul de Lacy

5.1 Introduction

The core of Echeverría and Contreras's (1965) (EC) description of Araucanian/Mapudungun[1] stress is given in (1).*

(1) *Echeverría and Contreras's (1965: 134) Araucanian/Mapudungun Stress Description*

a. GENERAL RULE: a phonological word has a main stress on the second syllable and, if applicable, secondary stresses on the fourth and sixth syllables: /wulé/ *tomorrow*,/ṭipánto/ *year*, /elúmuyù/ *give us*, /elúaènew/ *he will give me*, /kimúfalùwulày/ *he pretended not to know*.

EC's description has been cited as evidence for a variety of metrical theories (e.g. Hyman 1977: 41–2, 75; Kager 1993: 409; Hung 1994: 177–80; Hayes 1995: 266; Gordon 2002: 522; Hyde 2002: 320–5; McGarrity 2003: 59–61; Tesar 2004: 220–1). As a source of stress evidence, it is fairly typical. Large stress studies such as Hayes (1995) and Gordon (1999) overwhelmingly rely on descriptions like EC's (i.e. journal articles, grammars). In Gordon's (1999: appendix 1) list of 392 stress systems the mean publication date for earliest sources is 1972 and the median is 1975, so EC is slightly older than the average.

The issue addressed in this chapter is whether EC's description *should* be used as evidence for phonological theories.

The general issue – how to evaluate phonological evidence – has been addressed implicitly and explicitly before (e.g. Ohala 1986; de Lacy 2009). A theme of this chapter is that the source of requirements on evidence is theories themselves. Different theories of phonology impose different requirements

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[1] The metrical stress literature cited here uniformly refers to the language as 'Araucanian'. However, Zúñiga (2000: 4) comments that "this name is rejected by both scholars and the indigenous organizations", so 'Mapudungun' will be used here.

on evidence. Here, the focus is on generative theories of phonology (Chomsky and Halle 1968 and later theories in their framework).

Generative theories have a Phonological Module (PhM) that creates output representations that are translated by later modules into instructions to articulators; articulatory movements cause air perturbations which are perceived by hearers as speech sounds. The theory of production and perception of speech identifies many places in the process where recovery of the PhM's output can be 'distorted'. So, for any data, all sources of potential distortion must be examined to correctly recover the PhM's output state.

The distorting aspects of modules and mechanisms discussed in this chapter are well known; nothing new is proposed. The aim is instead to apply that knowledge and use it to determine evidentiary requirements. The examination will not be comprehensive – there are too many factors to allow detailed examination in so few pages. However, enough of the major distortion sources will be covered to illustrate the general approach.

In short, the aim here is to identify some of the requirements that generative theories impose on evidence for states of the PhM, and determine whether EC's description satisfies those requirements.

An overview of the theory is given in section 5.2, and is used as a template for evaluating EC's description in section 5.3. I emphasize that this chapter is *not* a critique of EC, nor does it attempt to determine the stress system of Mapudungun. The goal is to evaluate whether EC's description is relevant and adequate evidence for a generative metrical theory – a point discussed further in section 5.4.

The concerns expressed in this chapter relate to work on methodology of descriptions and analyses of stress. In this book, relevant discussion can be found in the chapters by Hualde and Nadeu, Hyman, and Gordon.

5.2 Theoretical framework

The theoretical framework employed here is the generative theory of phonology, as proposed in Chomsky and Halle (1968) and developed in subsequent generative theories (e.g. Lexical Phonology and Morphology – Kiparsky 1982; Optimality Theory – Prince and Smolensky 2004). There are many generative metrical theories and subtheories, including Hayes (1981), Prince (1983), Kager (1993), McCarthy and Prince (1993), Hayes (1995), and Hyde (2002). Aspects of the system that are particularly relevant will be summarized here; the purpose of this section is to provide a framework for discussing the adequacy of EC's description in section 5.3.

At the core of the generative framework is the Phonological Module – a cognitive component that transforms symbolic representations. The PhM's input consists of strings of phonological symbols sourced from the Lexicon;

at least some aspects of morphological and syntactic structure are visible to the PhM's transformations (e.g. Ussishkin 2007; Truckenbrodt 2007) (Figure 5.1 does not make any claim about exactly how the morphological and syntactic modules relate to the PhM; it merely acknowledges their influence).

Every theory of the PhM specifies possible and impossible states of the PhM. For example, *SPE* and its successors defined possible rules and orderings/interactions (Chomsky and Halle 1968; Kiparsky 1982) while work in Classical OT specified constraints and possible rankings (Prince and Smolensky 2004).

Of course, the best evidence that a particular output state of the PhM exists would consist of phonological outputs. Unfortunately, so far there is no way to directly detect phonological outputs. Instead, the available devices measure the output of post-PhM modules and mechanisms. The most commonly reported type of evidence for PhM states is 'perceived speech sounds': i.e. a hearer's perception of a speaker's speech sounds. Perceived speech sounds are far from the speaker's PhM output, as shown in Figure 5.1.

The PhM's output is sent to the Phonetic Module, which creates a gradient representation that is implemented as articulator movements by the neuro-motor interface. The articulator movements create variations in air pressure and flow (e.g. Löfquist 1997). These perturbations reach the ear of the hearer, and his/her perceptual system forms a representation of what was perceived.

There are many modules and mechanisms between the speaker's phonological output and the hearer's perception. When using perceived speech sounds as evidence for PhM outputs, then, the contribution of all those modules and mechanisms to the perceived speech signal must be considered. It would be an easy task if all of the post-PhM modules and mechanisms were straightforward: i.e. they translated the output of the previous module/mechanism in a 1:1 fashion. However, it is likely that all of the modules/mechanisms are distorting in the sense that their translation can obscure input distinctions and introduce new elements to the speech signal, so making recovery of their input difficult.

The following section will expand upon the distorting effects of the modules/mechanisms and how such distortion affects the validity of evidence for the PhM. The focus is on perceived speech sounds because they are the most common type of evidence used for phonological theories: grammars and journal articles typically use descriptions that report an analyst's interpretation of their perception of a subject's speech sounds. Of course, perceived speech sounds are not the only source of evidence for the PhM. Idsardi and Poeppel (2010) provide an overview of neurophysiological techniques in measuring cognitive events. There are also 'intuitions' – a subject's verbal report of their beliefs about their speech (Chomsky 1965: 18ff.; cf Kawahara 2011: §1.2 and references cited therein).

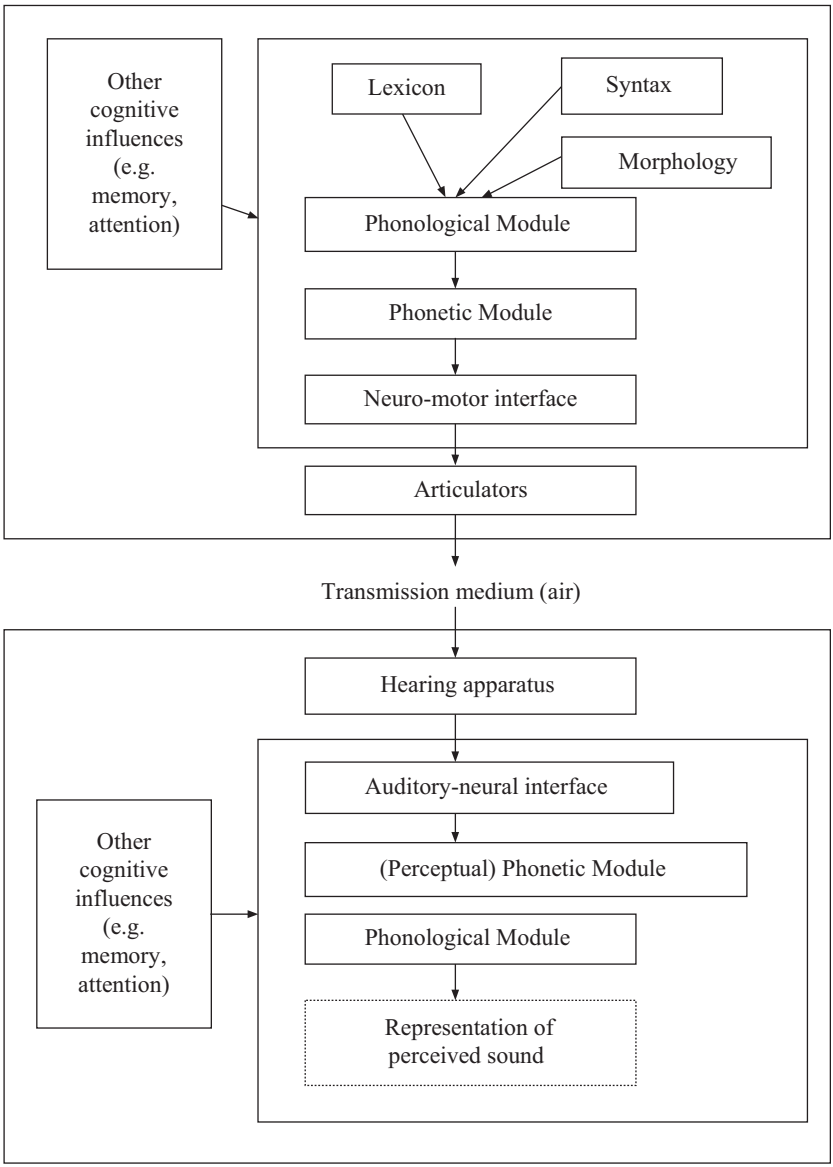

Figure 5.1 The PhM's role in generating human-perceived speech sounds.

In some situations, the perceiver is a machine – a sound recording and processing device. However, the same issues arise with mechanical recording devices as with humans: the machine's equivalent to an ear is a microphone, the auditory-neural interface is equivalent to a sound card, and the software used to transform the speech signal is analogous to the human's perceptual system (discussed in section 5.3.7), so similar distortion issues arise.

The final step is not represented in Figure 5.1 – where the hearer/analyst goes through a process of expressing the perceived speech sound in written form in an article or grammar. Aspects of the potential distortions produced at this final stage will be discussed in section 5.3.9.

5.3 Echeverría and Contreras (1965)

As mentioned in section 5.1, EC's description of Mapudungun has been used as evidence for metrical theories in many publications. EC's description is significant: Hayes (1995: 71, 75) proposes that iambs are always Quantity Sensitive, but EC apparently describes a Quantity-*Insensitive* left-to-right iambic metrical system (Gordon 2002: 522, 545; see section 5.3.9 below for further discussion). Apart from its theoretical significance, EC's description is so compellingly straightforward that it has often been used to exemplify left-to-right iambic rhythm (e.g. Kager 2007: 204–5).

The articles and books that cite EC's description do so for a theoretical purpose: they propose theories that predict a particular state of the PhM should exist, and EC's description is presented as evidence for that state. However, as there are so many influences on perceived speech sounds other than the PhM, EC's description must be examined to see if all those other distortions were taken into account.

The theme in the following sections is that the theory of the PhM and all the modules and mechanisms that influence it predicts where distortion can arise to obscure the PhM output's structure. So, the theory imposes requirements on the evidence that is presented for it in the sense that a comprehensive analysis will examine the potential sources of distortion and correct for them to recover the phonological output.

The following discussion does not aim to be comprehensive, advocate any particular techniques, or determine the metrical system of Mapudungun.[2] Instead, the goal is to illustrate the point that the theory is the source of requirements on evidence by determining EC's value as evidence for generative metrical theories.

[2] There are many other descriptions of Mapudungun stress. Section 5.3.9 identifies and discusses major grammars; Fabre (1998) and Zúñiga (2006: 68) provide extensive bibliographies about Mapudungun phonology. The most recent work I am aware of is Molineaux (2012).

An important publication that must be mentioned here is Echeverría (1964) (hereafter E64). The connection between EC and E64 is not entirely clear because neither work cites or discusses the other; however, it is possible that EC relied on E64's recordings to a great extent. Regardless, the goal of this chapter is to consider specifically whether EC alone provides adequate evidence because EC is always the source that is cited in theoretical phonological literature on stress; E64 is not mentioned, except by Molineaux (2012). E64 will only be discussed when it gives insight into EC, or when a comparison between the two works is particularly illuminating (e.g. section 5.3.9).

5.3.1 The Lexicon

The forms in (2) are the ones usually presented to illustrate Mapudungun stress. A natural interpretation is that they show the work of a PhM process – i.e. metrical construction of non-exhaustive left-to-right iambs.[3]

(2) *Basic stress forms (EC p. 134)*
a. /wulé/ 'tomorrow'
b. /ṭipánto/ 'year'
c. /elúmuyù/ 'give us'
d. /elúaènew/ 'he will give me'
e. /kimúfalùwulày/ 'he pretended not to know'

However, the Lexicon can – in a sense – distort evidence for PhM mechanisms. The underlying phonological strings of lexical entries may specify stress position (e.g. Alderete 2001 and references cited therein). If the PhM preserves lexically specified stress then the stress reported in (2) may not be evidence for a metrical PhM process, but rather simply be preservation of underlying stress. There are therefore two potential sources for stress location: the PhM's metrification processes and the Lexicon.

EC present the forms in (2) as exemplifying a predictable process: "Stress is predictable with reference to the phonological word . . . Stress is accounted for by one general rule and four special rules . . . " (EC p. 134). For a generative phonologist, a natural interpretation of EC's comments is that there is a productive PhM metrification process, and the data provided is representative of the output of that process. However, do EC present adequate evidence for a metrification process? In (2), only one form is given for each word length. For example, only one form is cited for two syllables: /wulé/. Could this form

[3] Here and throughout data is cited verbatim from EC. My understanding of the IPA equivalents for EC's non-standard symbols is: t̯], ṭ = [ʈ], ṭʳ = [ʈʂ], n̯ =], l̯], ɫ = [ʎ], i̯ = [j]; /ï/ is [ɯ] in stressed position and [ə] in unstressed position.

have lexical stress, and the default metrification process produce initial stress, at least in disyllables? In some iambic systems disyllabic words are reported to have consistent initial stress, so it is not impossible that /wulé/ preserves a lexical stress while the default position is the initial syllable (e.g. Southern Paiute – Sapir 1930: 39).

So how many disyllabic forms would one need to be assured that the PhM metrification process assigned stress to the second syllable? The best answer may be 'As many forms as the learner needs to converge on a metrical system with default final stress in disyllabic words'. Unfortunately, while learners know exactly what the PhM is capable of and how many forms are needed to converge on a particular system, analysts do not (yet). So, other approaches must be used.

One might point out that if /wulé/ is a lexicalized form, then there should at least be *some* disyllabic form in which stress falls on the initial syllable; this idea follows from the assumption that if a learner was only exposed to σσ́ words and never heard σσ̀ words, the learner would always opt for a metrical system that assigned second-syllable stress.

EC do in fact cite disyllabic words with initial stress: e.g. /fílu/ 'snake', /čáo/ 'father', /rúko/ 'breast'. So, as both σσ́ and σσ̀ words are cited, there are two possibilities: either /wulé/ reflects a general metrical process and /fílu/, /čáo/, and /rúko/ have lexical stress, or the opposite is the case.

It is interesting that while the majority of metrical analyses of EC's description imply or assert that the default stress on disyllables is on the second syllable, EC state in a 'Special Rule' that: "Two-syllable words ending in a vowel may be stressed on either syllable, except particles (adverbs, pronouns, prepositions) which are always oxytone" (p. 134). It is possible that particles do not reflect the general metrical pattern but have a class-specific stress pattern. So, the original issue remains: for disyllabic non-particles, what does the default metrification process generate?

EC's description also raises a third option. The statement that CV(C)CV words "may be stressed on either syllable" could be interpreted as describing free variation – an interpretation made by Hyman (1977: 41–2). EC cite "/pu rúka/ ~ /pú ruká/ *in the house*", which does suggest free variation, but the stress difference might instead be conditioned by context that is not provided in the example. Other words are cited without suggestion that their stress position might vary freely (the exception is *red* which is cited as both /kélï/ and /kelí/ – EC p. 132).

To pursue the issue of data quantity further, one might expect that the default metrical pattern will be reflected in the largest number of forms: i.e. if a relatively larger number of σσ forms had final stress, then the metrification process by default assigns final stress. Table (3) summarizes the disyllabic forms cited by EC, arranging them by stress pattern.

(3) *EC: Stress position on disyllabic forms that are not particles*

Shape	Initial stress	Final stress	Total
CV.CV	15	4	19
CV.CVC	0	15	15
CVC.CV	3	2	5
CVC.CVC	0	3	3
ALL	18 (43%)	24 (57%)	42

Focusing on CVCV words, initial stress is default by a majority criterion. However, is there *enough* data here: would much more data reveal that the majority have final stress? While learners can resolve this issue, exactly how they do it is currently unclear: is there a certain ratio where (for example) if there are twice as many final-stressed forms as initial-stressed ones the metrical process is fixed as final stress? At the very least, given the variation in stress position observed in the data, I suspect that most phonologists would expect a great deal more data to resolve the issue.

The table in (3) underscores the difficulty of inferring a pattern from limited data. Of fifteen CV.CVC forms, all have final stress, suggesting a pattern. However, if fifteen initial stressed CV.CV forms are not convincing of CV.CV initial stress, then one wonders whether fifteen forms should be convincing that CV.CVC forms have final stress; it is possible that it is an accident of the small sample size that all the cited CV.CVC forms have final stress. The same point applies to CVC.CV and CVC.CVC forms. If in fact CV.CVC forms do have final stress, then EC's data do not match their generalization, and in fact the stress system is Quantity Sensitive with CVC syllables heavier than CV.

For CVC.CV forms, three have initial stress and two have final stress (there are three particles – not included in the table above – that have final stress). However, one of the initial stress forms is a Spanish loan, and one of the final stress forms is, too. That leaves three forms: two with initial stress, [wéṇtʳu] 'man' and /láfṭa/ 'small', and one with final stress, /kofké/ 'bread'.

So, given the data provided for EC, it seems that no conclusion about the metrical system can be drawn with certainty about (at least vowel-final) disyllabic forms; it is possible that some have initial stress and some have final, or that there is free variation, or both. There is little solid evidence on the basis of the data cited to determine which stress position is the default.

The majority of data cited by EC consists of disyllabic forms (forty-two forms); there are sixteen longer forms, summarized in (4). Longer forms have the appearance of being much more regular in stress location. For example, all six trisyllabic CVCVCV forms have medial stress. While two four-syllable and two five-syllable forms are cited with different stress patterns, it is possible that secondary stress was simply not transcribed for some forms. EC (p. 134.c2) comment that the only CV.CV́.CV.CV.CV̀C form provided has a suffix *-la*,

which shifts stress away from a preceding syllable (/l̪aŋ̍ímïwulày/ ‘he did not kill himself’; /y/ is possibly another suffix – EC do not provide morpheme decompositions). However, E64’s only five-syllable form /tɯlkéaliwén/ ‘crust’ (p. 51) has the same stress pattern and does not have the negative morpheme.

(4) *Trisyllabic and longer patterns cited by EC*

Syllables	Stress pattern	Forms	Total
3	CV.CV́.CV	6	
	CV.CV́.CV̀C	1	
	CV.CV́C.CV	2	
	CV.CVC.CV́C	1	10
4	CV.CV́.CV.CV	1	
	CV.CV́.CV.CV̀	1	2
5	CV.CV́.CV.CV.CV	1	
	CV.CV́.CV.CV̀.CV	1	
	CV.CV́.CV.CV.CV̀C	1	3
6	CV.CV́.CV.CV̀.CV.CV̀C	1	1

However, there is still some inconsistency in stress position in longer words: primary stress falls on the penult in trisyllabic /θuŋúlàn/ ‘I do not speak’ (EC p. 134), but on the final syllable in [umau̯tún] ‘to sleep’ (EC p. 133; [u̯] is the labio-velar glide [w]).

Finally, it is important to emphasize that most of the shapes and stress cited above are for non-surface forms – i.e. forms that are intermediate to the derivation; processes such as glide formation can cause stress rearrangement (see section 5.3.9 below).

Given that there is lexically specified (or freely varying) stress for disyllables and some longer forms, it seems reasonable to require confirmation that longer forms do not show variation. The problem is that ten, or three, or two, or one forms may not be enough to capture any variation patterns, or be convincing that there is no variation in longer forms.

A further concern is whether the assumptions behind the descriptive categories are correct. The terms ‘CV’ and ‘CVC’ lump together different sonority values even though it is known that some systems are sensitive to sonority distinctions (de Lacy 2007). In fact, an early description of Mapudungun stress – Augusta (1903: 2–4) – claims that stress avoids the lowest sonority vowel [ə]: e.g. *fótəm* ‘son’, rather than the expected final-stressed **fotə́m* (cf. *pəllí*, **pə́lli* ‘soul’). Similarly, the description assumes that all codas will be treated in the same way, even though some languages distinguish weight based on the sonority of the coda consonant.

A final assumption is that there are stress domains longer than three syllables in Mapudungun. However, individual morphemes seem to be maximally

trisyllabic – all longer words cited by EC appear to be morphologically complex. In fact, Salamanca and Quintrileo (2009) state that words have maximally three syllables in the Tirúa dialect of Mapudungun. Limits on word size or stress domain size have been documented for a variety of languages (Ketner 2006). In E64's list of words and phrases, the transcriptions of almost all words longer than three syllables are accompanied by an intonation symbol, perhaps indicating that they are phrases rather than single words. It would therefore be valuable to know whether words longer than three syllables constitute a single stress domain (i.e. prosodic word), or whether they always consist of several domains. If domains are maximally trisyllabic, then there can be no evidence for alternating stress.

In summary, a closer inspection of EC's data leads to uncertainty about the stress system. There may be lexical stress or free variation, or both in different environments. It is unclear what the default metrical pattern is; a 'majority criterion' is not helpful due to the small amount of data cited. Of course, apart from the data there remains EC's prose description of stress location. However, without a clear understanding of how their description relates to the data, any reliance on their assertions would merely be an appeal to authority – that is to say, accepting EC's description as correct depends on one's personal confidence in the describers, rather than on the basis of evidence.

While the Lexicon can present challenges in determining metrical systems, it can also provide opportunities. If words could be identified that were sure to have no underlying lexical stress, the theory predicts that they would undergo the productive metrification pattern. For example, the stress pattern of loanwords might be used (e.g. Hayes 1995: 143 for Fijian). EC cite /sánču/ 'pig' and /kensá/ 'maybe' as loanwords from Spanish; unfortunately, these forms have the same stress as the source language (*chancho* [tʃáɲ.tʃo], *quizá* [kisá]), offering the possibility that the source language's stress was preserved (for discussion of the complexities of loanword stress adaptation see Broselow 2009). A wug test could be revealing, as long as analogical influence was controlled for (Berko 1958; see Kawahara 2011: §2.1.1 for discussion re phonological research); EC do not report the stress for any novel words.

A final consideration is class-specific behavior: a PhM can have more than one productive metrification process with different patterns for different classes of word (e.g. English nouns vs. verbs vs. adjectives – Burzio 1994: 43ff.); morphological boundaries also influence stress domains (e.g. Nespor and Vogel 1986: chapter 4). While EC's examples are not accompanied by a morpheme-by-morpheme decomposition, it seems that the majority of long forms are morphologically complex: e.g. /elúaen/ 'you will give me', /elúmuyù/ 'give us', /elúafimi/ 'you will give him', /elúaènew/ 'he will give me', [mawḯnài] 'it will rain tomorrow', /kimúfalùwulày/ 'he pretended not to know'. With the paucity of examples longer than three syllables, the issue of influence of

morpheme boundaries cannot be usefully examined. However, there is some suggestion that morpheme boundaries *might* influence stress placement: EC comment that for /-la/ 'negative', "the secondary stress is shifted from the fourth to the fifth syllable" (/l̪aŋ̍ímïwulày/, */l̪aŋ̍ímïwùlay/ 'he did not kill himself'). Smeets (1989: 61) identifies several suffixes with fixed stress, suggesting that they either have lexical stress or that their morpheme boundaries influence stress placement in such a way as to ensure that they receive stress. Without morpheme-by-morpheme glosses, it is difficult to determine whether EC's data reflects morphological influence. Similar issues arise for the Syntax module.

In short, the theory of the Lexicon requires that the issue of lexical stress be examined in any set of data. There are a variety of techniques for doing so, such as citing a great deal of systematic data and using tests for generativity. EC's description underlines the importance of addressing the issue: they describe variation in stress position, especially in disyllables. However, there is inadequate data to be sure of the default metrification pattern, or of the generalizations about other aspects of stress (e.g. where primary and secondary stress falls, where CVC attracts stress, the interaction of morpheme boundaries with stress).

I add that EC provide more stress transcriptions than I have seen in a number of articles and grammars; I have seen some that have no data at all, and some that list only a few forms. It is only because EC provide so much data that the difference between their generalizations and the data presented can be seen: without adequate data there is no way to evaluate the evidentiary basis for the describer's generalizations.

5.3.2 The PhM: L1, L2, and fluency

As a linguistic module, the PhM has properties such as L1/L2 status and fluency (occasionally called 'native speaker' status).

There are significant differences between L1 (or 'native') and L2 (or 'non-native') modules (Bley-Vroman 1988; Cook 2000; for the L1 vs. L2 acquisition of stress, see Archibald 1995). The challenge in investigating an L2 module is that it is unclear whether its output only reflects the workings of that particular module, or whether other computational resources have been used (such as L1 modules, other L2 modules, or general cognitive processes). So, the stress output of an L2 module may not reflect a single coherent metrical system, but rather a complex mixture of metrical systems and lexical specifications. Similarly, intuitions reported about an L2 by a speaker might not draw on the same cognitive resources as L1 judgments (Davies and Kaplan 1998). In contrast, it seems likely that the output of an L1 module is influenced only by that module; so, the output of an L1 module provides a clearer window into the possible states of human PhMs.

PhMs can also be 'fluent' or 'non-fluent' (or 'fully developed' and 'not fully developed'). For example, a child can learn a language but have his/her learning cut short, and so not develop a large vocabulary or be confident in giving intuitions about acceptability. This is the case for a subject I worked with who grew up in Germany. He learned German until the age of eleven, then left to live in an English-speaking country where he heard no German (even his parents avoided speaking German to him). Although his German PhM is L1 by the critical period criterion, his vocabulary is small and he is unable to express intuitions about sentence and word acceptability.

Strictly speaking, fluency is irrelevant to the overall goal: to determine possible states of the PhM. If every stage of language development employs a possible state of the PhM, then a less than fluent speaker (e.g. a young child) still has a possible PhM state, and determining the form of that state helps achieve the goal. However, there are practical problems when using data from less-than-fluent adult speakers: they may be more likely to code-switch in elicitation tasks, or draw on vocabulary and phonological patterns from their dominant adult language. The result is a set of data drawn from different PhMs.

So, to use EC's description as evidence for the claim that the PhM has a state that generates left-to-right iambs, the L1 status of the subjects' PhM must be determined. The worst-case scenario would be if EC's speakers' 'Mapudungun' PhMs were all L2, and their stress was influenced by other PhMs (e.g. their L1 PhM) in such a way that it did not reflect any possible individual PhM metrical system. In this case, EC's description would not reflect a possible state of the PhM, but would only be a collection of disparate data.

EC report the following about their subjects: "Our study is based on material elicited (and recorded) from five informants, all of them from the Cautín province in Chile" (EC p. 132). The article implies that all the informants speak Mapudungun. No further information about the subjects is given.

EC does not include an assertion that the speakers were native speakers. Techniques for assuring L1 status can involve the subjects answering questions about their linguistic history, such as the language they grew up speaking, or other externally verifiable criteria (e.g. Labov 2006: 118–19).

I am not claiming here that Echeverría and Contreras were unaware of the issues surrounding L1 status or that they did not use techniques for determining L1 status. The observation is that EC does not report L1 status or their techniques, and so the implication for those who wish to use EC's description for generative theories is uncertainty.

In fact, there is clear evidence that Echeverría was aware of the importance of L1 status. E64 is a lengthy description of the phonology of Mapudungun, and it is highly likely that at least part of EC is based on the same recordings. E64 (p. 19) notes "El primer paso para realizar nuestro estudio fue ubicar los

hablantes nativos que proporcionaran el material lingüístico necesario" ['The first step in our research was to locate native speakers to provide the requisite linguistic data.' – my translation]. It is possible that EC relied entirely on E64's data – they both mention "five subjects". Unlike EC, E64 (pp. 19–20) provides a great deal more information: for each subject their name, age, occupation, residence, and linguistic information are provided. For example, José Ailío Huaracán was born in Cautín province, lived in Concepcíon for more than ten years, was thirty-five years old at the time of fieldwork, had primary school education, and had learned Mapudungun as a child (E64 p. 19).

This chapter is about EC's description and whether it can be used as evidence for generative theories, so I am reluctant to delve too far into E64's description. However, it is striking how EC and E64 differ: EC provide almost no information about their subjects while E64 provides several important details that are crucial for generative theories. E64 (pp. 19–20) notes that four of the five subjects learned the language while they were a child – an essential condition of L1 status. Fluency was also a concern: E64 (p. 20) notes that two subjects spoke the language at home, and one spoke it frequently. (For two subjects, there is no indication of how often they spoke it. For example, while Lorenzo Chicahual learned the language as a child, he had lived in Temuco for decades and there is no comment on whether he spoke the language regularly.)

Currently, Mapudungun is a minority language even among the Mapuche: of 700,000 Mapuche, 200,000 people speak the language fluently; the majority are bilingual (Zúñiga 2000: 4; UNPO 2008). EC estimate that there were about 100,000 speakers in 1965 in Chile. With just the information provided by EC, it is not possible to have confidence that the speakers were native speakers. If E64's information is taken into account, it is at least clear that all of the speakers were bilingual. However, for L1 status the details are still murky. One of the subjects may not have learned the language young enough, and a few may not have spoken the language regularly for many years.

Even though four of the speakers said that they spoke the language as a child, this criterion alone is not an adequate diagnostic tool for L1 status. This point is underscored by E64's (p. 20) comment. One of the subjects – María Catrileo – listened to the recordings of another subject – Ailío. Her opinion, combined with Ailío showing 'repeated ignorance of vocabulary and inconsistent pronunciation', led to Ailío being dismissed. ("En un estado avanzado del analisis del material, fue necesario desestimar al informante Ailío por presentar repetida ignorancia de léxico y pronunciación inconsistente" – E64 (p. 20)). It is possible that Ailío was not a native speaker of Mapudungun. If so, the fact that he self-reported that he had learned the language since he was a child was an inadequate diagnostic for determining native-speaker status.

In general, it is far from easy to be sure that a person is a native speaker. In my own fieldwork on the Polynesian language Māori, I found that a number

of people said they spoke Māori fluently or natively but actually knew only a few words; by saying they spoke Māori they were instead expressing a strong emotional connection to Māori culture. Some people reported speaking the language as a child, but close questioning revealed that it was not their primary language, and it was used in a classroom situation and not among their peers (e.g. never while playing). In contrast, one native speaker was very reluctant to say she spoke Māori; she was concerned that she did not have enough prestige to be a research subject.

Nowadays, there seems to be an expectation that only native speakers will be used in linguistic descriptions. However, different attitudes seem to have prevailed in earlier descriptions. For example, in Williams's (1917) dictionary of Māori, the preface reports that the data was taken primarily from secondary sources (e.g. dictionaries, word lists, texts) compiled by Europeans (non-native speakers). In the 'Methods' section, Williams comments:

(5) *Methods for ascertaining wordforms in Māori (*Williams 1917*)*

> There are various methods of ascertaining the meaning of a Maori word . . . The most natural procedure is to enquire from an intelligent Maori of the older generation, or preferably from several such. But this course, now unfortunately seldom available, is not always free from the risk of error. Few Maoris can resist the temptation to oblige an enquirer rather than admit ignorance; and occasionally a Maori may, in all honesty, have been habitually misusing a word in his own tongue. Moreover, local usage in respect of words is frequently very curious and perplexing.

So, Williams (1917) considered native speakers to be an important but imperfect source of information – they were prone to "frequently . . . curious" misuse of their own language. The preference was for secondary sources compiled by non-native speakers (e.g. Colenso's dictionary, "Mr Atkinson's papers", Sir George Grey's collection, the Rev. Father Becker of Hokianga's word lists, Mr S. Percy Smith's word lists, and so on), including Mr Elsdon Best, who had "intimate acquaintance with the Maori", and "supplied a very large number of words, new meanings, and examples, collected at first hand".

In summary, without a clear description of the method for determining L1 and fluency status, there can be no reasonable assurance that subjects are appropriate sources of PhM evidence, as required by the theory.

Even if a PhM is L1, its output might not give insight into how PhMs usually work if it has been impaired (e.g. Stemberger and Bernhardt 2007; Cummings 2008: 265ff.; Bernthal *et al.* 2009). It is somewhat hard to tease apart impairments of the PhM from Phonetic Module impairments, or even neuro-motor impairments (Haynes and Pindzola 2011: chapter 6). However, a number of disorders have a phonological character in that they refer to phonological

restrictions (e.g. den Ouden 2002). For example, jargon aphasia is where a person produces incomprehensible utterances, such as [dɛlkwɑɪ] for 'lobster' and [ædɛpgʊd] for 'spade' (Rohrer *et al.* 2009). Zeigler and Maassen (2004: 427) observe that a striking feature of neologistic jargon is that it conforms to syllable structure conditions, suggesting that the problem is within the Phonological Module, or with the transmission of lexical information to the Phonological Module (Butterworth 1979). Similarly, some neurological conditions can affect lexical access and the Phonological Module (e.g. schizophrenia can result in lack of realization of an affix's phonological material – Cummings 2008: 365).

5.3.3 The PhM: multiple modules and pooling

Generative theories allow for a single human to have more than one PhM. This situation is most obvious in the case of those who speak two different languages natively; they have distinct PhMs – one for each language (Genesee and Nicoladis 2007). For the same reason, people who speak distinct dialects of the same language natively arguably have more than one PhM.

An individual may also have several different speech styles – a particular way of talking depending on the social context (Labov 1972; Trudgill 1999). Some speech styles' phonological properties can differ in significant ways. For example, many Sāmoans have (at least) two speech styles: *tauta lelei* has the stops [p t k m n ŋ] while *tauta leaga* has [p k ʔ m ŋ] (Mosel and Hovdhaugen 1992: 20–4). In my own speech, I have styles that differ in /l/-vocalization, flapping environments, and declarative intonation tunes (Bye and de Lacy 2008: §6). Distinct speech styles might be generated by different PhMs. Alternatively, a single PhM could generate several speech styles if processes are indexed for speech style (see Coetzee and Pater 2011: §4.5 for an overview of formal theories of speech style), though for our purposes indexing has the same effect as multiple PhMs: each configuration of active processes (e.g. active rules/rankings) is a different state of the PhM, and the goal of generative phonological research is to determine the range of possible PhM states.

Taking languages, dialects, and speech styles into account, it is likely that there is no adult human who has only one PhM. So, it is not possible to assume that all the speech that comes from one human comes from the same PhM.

It is crucial to know whether a set of speech data was generated by a single PhM or is an amalgam of several PhMs' outputs. In the latter case, the resulting data might not reflect *any* possible state of the PhM.

For example, the dataset [bə́ʊ] *bill*, [bə́l-əŋ] *billing*, and [mí:tə] *metre* could be elicited from my speech. From these forms, one might conclude that I have a PhM that has (i) /l/-vocalization (/l/→[ʊ] outside of onsets), and (ii) no flapping of /t/. However, I have *no* such PhM. The data is a mixture of outputs

from different PhMs: my informal speech style's PhM has /l/-vocalization and extensive flapping ([mí:ɾə], [hɔ́spəɾəʊ] *hospital*, cf. [hɔ́spətli] *hospitally* 'somewhat like a hospital'), while my formal speech style's PhM has no /l/-vocalization and very restricted flapping (allowed only after short stressed vowels: [bʌ́ɾə] *butter* vs. [mí:tə], [hɔ́spətɫ] *hospital*) (Bye and de Lacy 2008: §6). So, assuming that [bə́ʊ], [bə́ləŋ], and [mí:tə] are generated by one PhM leads to a mistaken analysis of my PhMs' capabilities. However, suppose that it is impossible for *any* PhM to lack flapping and have /l/-vocalization. In this case, the erroneous assumption seriously derails the understanding of PhM capabilities.

So, it is an error to assume that all data from a single human was generated by the same PhM; such assumptions can lead to incorrect conclusions about possible PhM states. In practical terms, elicitation must be controlled for language, dialect, and speech style: techniques to keep the elicited data coming from an L1 module – i.e. track and prevent code-switching and style-shifting – are essential (e.g. Milroy 1987: 60ff.; Milroy and Gordon 2003: chapter 8; see Broselow *et al.* 1997: 52 for an example). EC do not report their elicitation techniques or whether they determined L1 status. However, E64 (pp. 20–1) states that his recording sessions were about 40 minutes long, and comments further:

(6) *Description of scene-setting in Echeverría (1964: 20)*

Estas reuniones se realizaron siempre en una atmosfera de confianza, y varias veces fueron precedidas de conversaciones informales relativas al tiempo, el trabajo particular del informante, etc. Pudimos notar que sentían orgullo por colaborar en este estudio de su lengua. ['These meetings were always conducted in an atmosphere of trust and confidence, and were usually preceded by informal discussions about the weather, the participant's job, etc. We observed that they were proud to participate in this study of their language.' – my translation)

The steps taken were no doubt intended to reduce the subject's anxiety. However, it is not clear that they would have activated the subject's L1 Mapudungun vernacular module. The preliminary discussion was no doubt in Spanish, and using informal Spanish might not have prompted the subject to use vernacular *Mapudungun* – formal Mapudungun might still have been used. Labov (1984) and Wolfram (2011) provide overviews of techniques for controlling speech style and style-shifting.

EC do not discuss whether code-switching between Spanish and Mapudungun occurred. The subjects were bilinguals and the elicitation was done in Spanish (E64 pp. 19, 20), so code-switching and code-mixing could have been frequent, and may have influenced the prosody of Mapudungun words. For example, Gu *et al.* (2008) report that in Cantonese–English code-mixed

speech the prosody of the embedded language (English) was significantly influenced by the matrix language (Cantonese). There is also no mention of how speech styles were controlled, or which speech style the data belonged to. For example, there is no information about the scene-setting that was given to the subjects.

EC do state that five subjects contributed to the project. Presumably their data was pooled (there is no indication of who contributed which word). So, the reported data almost certainly came from several different PhMs, all of which could have had different stress patterns. Quite apart from idiolectal variation, the subjects could have been speaking different dialects. Given Mariá's rejection of Ailío's speech discussed in the previous section, it is possible that he spoke a different dialect – or even language – from the others.

Even if the speakers used only their Mapudungun PhMs and – conservatively – each had three speech styles, then there is the chance that EC's description is the pooled data from fifteen PhMs. So any theory of EC's data would not be about a state of the PhM, but rather about pooled data from many PhMs which may not bear any resemblance to any possible PhM state.

One might think that the preceding comments are overly critical. After all, EC's description is remarkably coherent in that it seems to be a single unified system. Such coherence might reasonably be seen as indicating that the subjects all had PhMs that had identical metrical systems.

The best way to test this assumption would be to compare the same set of words from each speaker. However, EC gives no indication of who contributed which word (nor does E64). Going from EC's description it is even possible that the coherence is illusory: it could be the case that every speaker contributed different data, with no overlap. An example is found in Pankratz and Pike's (1967: fn. 1) description of Ayutla Mixtec, where the segmental phonology data and prosody data were elicited from different subjects. E64 (p. 20) provides further information, however: all speakers were asked to say two Swadesh word lists, were asked to say short sentences, and also told short stories. This elicitation procedure would allow for direct comparison between speakers, so differences could be noted in pronunciation. However, there is little indication by E64 or EC that such a comparison was undertaken.

E64 (pp. 47–8) also discusses another method employed: Mapudungun sentences were read to one subject (María Catrileo) with varying stress. She was asked to say whether the pronunciation was acceptable or not. If María Catrileo's responses were the sole basis for determining the stress system by EC as well as E64, then the results come closer to being useful for generative analysis: the results were not pooled, and so likely to have come from a single L1, given María's native-speaker status and frequent use of the language.

If the speakers had different PhMs, then some apparently 'free variation' in the data might be expected. In fact, EC report a great deal of allophonic

variability. For example, "in final unstressed position, the nuclei /u/ and /o/ alternate" (EC, p. 134). It is not clear whether this variation is seen within an individual's speech style, or whether /u/ is used in one speech style and /o/ in another, or one subject used /u/ and another /o/. Similarly, the word for 'red' is listed as both /kélï/ and /kelí/; there is no indication whether these words show free variation, speech-style difference, or cross-subject variation. Similarly, a "non-phonemic glide" may optionally appear word-initially before a central vowel (EC, p. 132), and much allophony involves free variation (EC, p. 133). Again, there is no way of knowing from the description whether the variation is truly free – i.e. varies within a single PhM – or that different PhMs generate different allophones.

Due to data pooling, there is even no way to know how to interpret the variability in stress reported for CVCV words. It is possible that one speaker has consistently initial stress, another had consistently final stress, another had free variation, and another had lexically determined stress. All possibilities fit the data provided.

To approach the issue from another angle, EC state that "2. Two-syllable words ending in a vowel may be stressed on either syllable . . . /pu rúka/ ~ /pú ruká/ *in the house*". A variety of PhM configurations could result in this data. Let us call a PhM which only produces /pu rúka/ 'P1', a PhM which only produces /pú ruká/ 'P2', and a PhM with free variation between /pu rúka/ and /pú ruká/ 'P3'. There are five configurations of PhMs which would fit with EC's statement: i.e. (1) P3 alone, (2) P1 and P2, (3) P1 and P3, (4) P2 and P3, and (5) P1 and P2 and P3. So, data pooling leads to significant uncertainty about which PhM states actually existed – the best conclusions to be drawn from the data are that (1) at least one of P1, P2, and P3 occurred, and (2) if P1 or P2 occurred then so did one other of P1, P2, or P3.

Finally, the relative coherence of the account may be illusory. The aim of the article seems to be to provide an account of sound patterns in the Mapudungun language. 'Language' is a socio-political concept, with no particular relevance to generative phonology; for generativist phonologists, the object of study is the PhM. The desire to describe a 'language' leads naturally to quashing variability: a language is a shared system of communication, so any language description is an account of normative behavior rather than of individual variation. In other words, the description might have aimed to identify general tendencies across all the speakers, and so omitted significant individual deviations.

One could argue that the validity of EC's description receives support from other descriptions that are very similar to EC's. Gordon (2002: 522) cites two other languages with left-to-right Quantity-Sensitive iambs, so one could assume that EC's description is *more likely* to be accurate than not. The problem

with this justification is that it assumes that there is strong evidence for the other descriptions.

To summarize, pooling data generated by different PhMs into one dataset is potentially irrelevant and at worst misleading. If by chance the PhMs are identical in the relevant way, then the pooled dataset has no effect on the validity of the conclusions one can draw about the possible states of the human PhM. If, however, the PhMs are not identical, then the resulting dataset may not represent any possible state of the PhM, and theories of the PhM that rely on such evidence are not valid.

Data pooling in descriptions is ubiquitous. There are three reasons for pooling. One is that the aim of many descriptions is to describe a 'language': a set of generalizations about a group's communicative behavior (see further discussion in section 5.4). For this goal, pooling is necessary: it is the only way to identify group norms. Another reason is that the goal of an article can be to describe normative behavior rather than states of a cognitive module. In contrast, generative phonologists use data to identify states of the PhM, so pooling data from different PhMs can lead to the problems outlined above.

The third reason for pooling can be to minimize individual (random) variation. There are so many incidental influences on an individual's speech that irrelevant 'noise' might swamp generalizations. By pooling several people's data, it is hoped that the contribution of the Competence mechanisms will shine through. The problem with this approach is that it makes an a priori assumption that the speakers all have the same PhMs, or at least the same subparts of PhMs. Although the issues are complex, a more effective approach is to minimize individual variation by ensuring that data is elicited from the same PhM in an individual (i.e. controlling for code-switching and style-shifting), and that adequate amounts of data are elicited by using many different methods.

5.3.4 The PhM: process interaction

Generative theories of phonology have stress-sensitive phonological processes.[4] Typical stress-sensitive processes include vowel reduction (e.g. Crosswhite 2004), fortition (e.g. Bye and de Lacy 2008), and allophony (e.g. Beckman 1998). So, such processes can be a source of evidence for stress position, a point made for EC's description by Hayes (1995: 268). In fact, in the face of pervasive lexical stress, Altshuler (2009) crucially relied on phonological processes to determine the default pattern in Osage.

[4] Here, 'stress' in a phonological context refers to phonological elements that are realized as phonetic stress. Such elements include gridmarks (Prince 1983), and foot heads (e.g. Hayes 1981).

EC identify stress-sensitive allophonic processes:

(7) *Stress-sensitive allophony*

(a) */ï/*
The phoneme /ï/ has a high back unrounded allophone [ï] in stressed position, e.g. /kelḯ / [k̟elḯ] *red*, and a mid central unrounded allophone [ə] in unstressed position, e.g. /ṭómï/ [tʳɔ́mə] *cloud*. (EC, p. 132)

(b) /u/∼/o/
In final unstressed position, the nuclei /u/ and /o/ alternate: /fílu/ ∼ /fílo/ *snake*. (EC, p. 134)

(c) Intonation
Intonation is predictable from stress . . . and juncture. (EC, p. 134)

Of course, it is necessary to put the claims in (7) through the same rigorous evaluation as the stress system. For present purposes let us assume that they are all valid and reflect active phonological processes. In practical terms, the allophony of /ï/ has the potential for independent evidence for the position of stress in twenty of EC's seventy-two forms. For example, the word /mïlṭ́ïn/ 'a kind of bread' would presumably be realized as [məlt̪ɯ] (/ï/ is IPA [ɯ]), not *[mɯlt̪ɯ], *[mɯlt̪ə́n], or *[məlt̪ə́n]. EC provide fifteen surface forms that show the [ə] ∼ [ɯ] allophones. However, the majority of their data consists of non-surface forms so the allophones of /ï/ are not shown. Consequently, though the allophony is a potential source of evidence, the evidence itself – i.e. the allophonic transcriptions of forms – is not provided systematically in the description.[5]

EC mention an apparently related process where "phonetically complex onsets . . . alternate with [CəC] sequences, and are analyzed phonemically as /CïC/, e.g. /kïθáw/ *work*: [kəθáu̯] ∼ [kθáu̯]" (EC, p. 134). As a diagnostic for stress position, this process does not add to the observation from /ï/ allophony that [ə] inhabits unstressed syllables. Smeets (1989: 63) considers this process epenthesis, and observes that insertion of [ə] is not sensitive to stress position – the inserted schwa can receive the stress.

The same point can be made for (5b): the /u/ ∼ /o/ alternation. I interpret the statement as meaning that /u/ and /o/ are in free variation in unstressed final position. Therefore, wherever final /u/ and /o/ do not freely vary, they must be stressed. This process would be useful in identifying stress position in six of the forms that EC cite (e.g. /elúmuyù/ 'give us' should not vary with */elúmuyò/; /ṭipánto/ 'year' should vary with /ṭipántu/). However, no comment is made on /o/ ∼ /u/ variants of each form. For example, 'woman' is listed as /θómo/, and no /θómu/ variant is mentioned; no /o/-final variant of /sánču/ 'pig' is listed.

[5] The data that shows [ə] ∼ [ɯ] allophones consists of: [CVCə] (3 forms), [(C)əCVC] (8), [CəCVCV] (1), [CVCɯCVV] (1), [CVCɯ] (1), and [CVCɯjCV] (1).

EC also identify intonation as being sensitive to stress position. Interpreting their description in autosegmental terms, a phonological phrase has the tune LH*L where H* attaches to the leftmost (primary) stressed syllable and spreads to the rightmost primary stressed syllable in a Prosodic Word; moras may only bear one tone. For example, [{màn'sánà}{kɔ́ 'šílù}] 'sweet apple', [{wù'lé}{mà'wí̵ˌnài}] 'it will rain tomorrow', [{tə̀ɸ'éítˢí ṭʳɔ́mí̵}] 'that cloud?' (my interpretation of data from EC, pp. 134–5). So, an initial L tone is diagnostic of whether the first syllable is stressed or not, potentially distinguishing the stress in words such as /píči/ 'small' (i.e. as tonally ['ɔ́ɔ̀]) from /ŋïrí̵/ 'wolf' (tonally [ɔ̀ɔ́]). However, not enough intonation transcriptions are provided to demonstrate that the stress position on other data matches with the tones.

Overall, it is not the case that for every form cited there is corroborating evidence from /ï/ allophony, /u/ ~ /o/ variation, or L tone placement to determine whether the transcription accurately reflects the location of phonological stress. So, while the processes offer potential diagnostics for stress position, EC does not contain systematic data that exhibits these processes, so there is little evidence to support the claims about stress position.

Much more can be said about the PhM's internal processes. For example, many generative phonological theories allow stress to be sensitive to a variety of phonological environments and properties (e.g. tone, sonority, moraic content). So, adequate evidence will include forms that show the (in)sensitivity of stress to those contexts and properties.

Similarly, word stress and its realization interact with phrase-level prominence and intonation. Gordon (this volume) makes a particularly pertinent observation: in stress descriptions, the reported patterns often appear to refer to words spoken in isolation. In such cases, words are coextensive with utterances so word stress would interact with phrase-level intonation and prominence. For some descriptions, it might be impossible to tease word-level stress and phrase-level properties apart, leading to an inaccurate understanding of prosodic structure at the word level. EC do not state whether their stress description is based on words spoken in isolation or in phrases. So, EC's assertion that stress falls on the second syllable in /putún/ 'to drink' could be an observation about word-level stress, phrase-level prominence, intonation, or the interaction between these factors. Even if the words were extracted from a larger context, a variety of challenges arise: the realization of word stress can differ based on phrasal position, phrase-level prominence can be sensitive to factors that are different to word-level stress, and intonation might not match well with word-level stress. Lack of space prevents further exploration of this point here; the reader is referred to Gordon (this volume) for extensive discussion.

The broader point is that the phonetic manifestation of foot heads is not the only evidence for phonological stress. If word heads, foot heads, and foot

boundaries are present in the phonological representation, phonological processes can refer to them. So, such processes provide extremely important support for the location of phonological stress. An important caveat is that while certain phenomena can be sensitive to stress, they could be influenced by other factors. For example, Hyde (this volume) observes that descriptions of Tauya have claimed that the initial syllable is stressed because it resists vowel reduction. However, Hyde suggests that the lack of reduction could be due to special restrictions on word-initial syllables.

5.3.5 The Phonetic Module

In the production process, the PhM's output goes to the Phonetic Module, and is converted there into a gradient representation that is ultimately translated into articulator movement (Keating 1990; Kingston 2007: §17.4.3). There are many different conceptions of how the PhM and Phonetic Module interact (Löfquist 1997; Kirchner 2001). For present purposes, what matters is that the translation of phonological forms into instructions for articulatory movements can introduce distortion.

The Phonetic Module is not straightforward: it is not the case that every phonological element has a realization that is invariant across speakers, or even for one speaker in different contexts (Kingston and Diehl 1994). In fact, a variety of work has shown that phonetic processes can obscure phonological information. For example, anticipatory coarticulation can make a phonological [np] be realized as (something very close to) a phonetic [mp] (e.g. Browman and Goldstein 1995). The Phonetic Module also adds structure, as in tonal interpolation (Gussenhoven 2007: §11.3), or featural interpolation (e.g. Choi 1995). It can also displace phonological symbols by realizing them out of temporal sequence (e.g. glottal stops realized as creaky voice in Pendau – Quick 2004; displacement of pitch accents – Gussenhoven 2007: §11.4.2). Finally, some phonological symbols have no direct phonetic realization (e.g. Cairene Arabic secondary stress; Allen 1975).

Phonological stress is particularly interesting because it has a variety of realizations. For example, stressed vowels can be realized with an excursion in fundamental frequency (F0), increased intensity, lack of spectral tilt, increased duration, vocalic peripheralization (or centralization in unstressed syllables), a combination of the preceding, or no realization at all (e.g. Lea 1973: 27ff.; de Jong 1995; Gordon 2011; and references cited therein).

EC do not describe the phonetic realization of stress.

A problem with not knowing the realization of stress is that the perceived stress could be an artefact of the analysts' perceptual systems. For example, if an analyst has a perceptual system in which the realization of stress involves

raised pitch, then the analyst may perceive raised pitch in the target language as indicating the position of stress. However, the speaker's stressed syllables may not be marked significantly by F0; instead, F0 may be controlled by incidental phonological factors (e.g. intonation) or phonetic ones (e.g. a rise in F0 word-initially).

Without a full analysis of how the subjects' Phonetic Modules realize phonological stress, it is not possible to be confident that EC's description of stress position is accurate. Nowadays, techniques to help avoid such difficulties are in common use (e.g. machine recording and sound analysis; Ladefoged 2003). Of course, such techniques were not widely available in 1965. In fact, E64 (p. 21) noted that spectrograms would have been very useful for transcribing, and that some aspects of Mapudungun speech were difficult to perceive (particularly dentals and retroflexes). However, the point remains that without a clear characterization of the phonetic realization of stress, and clear evidence that this realization does in fact occur where EC transcribed stress symbols, it is possible that EC misperceived stress.

Another difficulty with stress is that other phonetic processes can obscure it. For example, F0 is often higher phrase-initially than phrase-finally due to a possibly universal tendency for F0 to decline over a phrase (Ohala 1978: 31–2); this natural declination could be misinterpreted as initial stress. Similarly, a variety of phonetic processes cause changes in vowel length, such as pre-voiced consonant lengthening (Chen 1970), domain-initial strengthening (Cho and Keating 2009), and domain-final lengthening (Beckman and Edwards 1990). Where vowel length is an important cue to stress position for the analyst but not in the target language, such incidental duration changes could be misinterpreted as stress.

O'Keefe (2007) reports a pilot study of Mapudungun CVCV words to determine whether there were clear acoustic correlates of stress. Using limited data from audio recordings on the compact disc accompanying Zúñiga (2006), O'Keefe did not find significant differences between syllables in CVCV words: intensity was not statistically significant ($n = 13$, two-tailed t-test: $p = 0.198$), nor was F0 ($n = 13$, two-tailed t-test: $p = 0.064$). There was a significant difference in duration: final syllables tended to be longer than initial syllables (V1 mean = 76 ms, V2 mean = 97 ms; $n = 13$, one-tailed t-test: $p > 0.01$). However, the average difference of 21 ms is small and its perceptual significance is questionable; it is possibly due to domain-final lengthening. Even though O'Keefe (2007) did not work with EC's subjects, the uncertain results of his work suggest that identifying the correlates of stress among Mapudungun speakers is not straightforward.

In summary, without a clear understanding of the phonetic realization of stress, and of other interacting phonetic processes, there is an added element

of uncertainty in EC's description. It is possible that what EC describe is an artefact of their perceptual systems, or a misinterpretation of incidental effects on F0 as indicating stress position.

The preceding discussion might be read to imply that the only descriptions of stress acceptable for generative analysis are those that are accompanied by detailed analysis of phonetic implementation (e.g. Gordon 2004; Altshuler 2009). There has certainly been a significant rise in such work over the past several years (Cohn 2011). The issue of how the observations made here relates to the notion of 'acceptable evidence' is discussed in section 5.4.

5.3.6 The neuro-motor interface and articulators

The neuro-motor interface implements phonetic representations as articulator movement, and can be affected by a variety of disorders (Weismer 1997). Similarly, inherent properties of articulators can distort the PhM's output, and so can articulatory disorders (e.g. Bernthal *et al.* 2009).

Some articulatory-sourced distortions are found in all humans. Articulators cannot move as quickly as they are commanded in all situations. So, the shorter duration of unstressed syllables can mean that articulatory targets cannot be met in time, leading to vowel centralization (Lindblom 1963). Such centralization can create an ambiguity for the hearer/analyst: vowel centralization might be evidence for either phonetic centralization or phonological neutralization (e.g. Barnes 2002).

Certain articulations have inadvertent side-effects. For example, jaw and tongue height can inadvertently influence pitch, so that high vowels have higher F0 than low vowels (Whalen and Levitt 1995); there are many other similar influences on F0 (Lea 1973). So, even though the PhM can also influence F0 tonal specifications and stress, an F0 excursion is not unambiguous evidence for a PhM specification.

It is a challenge for the analyst to tease apart the effects of articulatory implementation from the phonetic representation (and then tease apart the phonetic and phonological representations). For example, jaw and tongue height affect duration, with lower vowels having longer inherent duration than higher vowels (Lehiste 1970). If duration is perceived as the cue to stress position, low vowels might be misinterpreted as having phonological stress. There is the chance that this particular articulatory effect might have led to misanalysis of inherent vowel duration as phonological stress – a possibility not considered in the most extensive surveys of sonority-driven stress (e.g. de Lacy 2004).

Articulators can vary a great deal between humans. For example, laryngeal size differs significantly based on age and sex (Beck 1997). An effect is that

average F0 for a ten-year-old male or female is around 260 Hz, for a twenty-year-old female it is around 200 Hz, and a twenty-year-old male has around 130 Hz. Apart from average F0, speakers apparently often differ in pitch range. F0 is often significant for the detection of stress. If stress is realized with an F0 excursion, the nature of that excursion may be significantly different for a speaker with a large pitch range compared with a speaker with a compressed pitch range. Similarly, pitch rises might be difficult to detect in speakers who have a higher average F0 as their pitch may reach its peak without much deviation from the average.

Trauma, medication, and disease can also cause articulator and neuro-motor variation (e.g. Weismer 1997). The sources of variation may be due to age degeneration or to a specific traumatic/disease event, and may be permanent or transitory. For example, a common age-related degeneration is loss of all natural teeth (edentulism). Edentulism can affect the production of dental sounds (e.g. [v], [θ]). In the United States, its prevalence is 2.3 percent for eighteen- to forty-four-year-olds (all races/ethnicities and incomes), and 25.3 percent for sixty-five-year-olds and older (age-adjusted).[6] The highest rate is among eighty-five-year-olds and older who are also poor and Hispanic (male and female data pooled) at 66.1 percent.

Alcohol is an example of a transitory influence: Chin and Pisoni (1997) provide an extensive discussion of research into the influence of alcohol on speech production and perception. They note that for one study, the "most consistent acoustic change was a significant increase in sentence durations, that is, a slowing of speaking rate under alcohol. In addition, control of abrupt closure and opening of the vocal tract were also affected by alcohol" (p. 184). They also observed increased pitch variability and impairments of fine articulations involving articulator timing.

With alcohol, the Phonological and Phonetic Modules are (presumably) intact, as are the articulators. The impairment seems to center on the neuro-motor interface, resulting in mistiming of articulatory commands. Chin and Pisoni (1997: 185) identify problems with the production of voiced stops, affricates, and stop clusters, all of which require fine control of articulator timing.

Alcohol therefore poses potential problems in the analysis of stress. If pitch alignment and duration provide cues to stress position, and alcohol intoxication interferes with the accurate timing of articulatory movement, the result could

[6] US Centers for Disease Control and Prevention (CDC): Health Data Interactive: Edentulism (loss of all natural teeth, ages 18+: US, 1998–2009 (Source: NHIS) http://205.207.175.93/HDI/TableViewer/tableView.aspx?ReportId=110 (last accessed February 6, 2012). The percentages are from table values as specified in the text.

be that an F0 excursion occurs in a place unrelated to where the PhM specifies it should be.

There are many ways in which the neuro-motor and articulatory mechanism can distort the intended realization of the PhM's output. For present purposes, the point is that impairments of the neuro-motor interface can make recovery of the PhM's output difficult, and even obscure it entirely (Weismer 1997; e.g. dysarthria – Bernthal *et al.* 2009: 172ff.; soft palate implants – Akpinar *et al.* 2010).

The practical implication is that certain physical properties of the data sources (i.e. the subjects) must be reported because they can distort cues to stress, leading to misanalysis. Sex and age are commonly reported; these properties at least give an indirect sense of potential characteristics of the speaker's articulators (Beck 1997). It is also apparently necessary to examine individual variation and impairment in at least the articulatory apparatus. If the elicitation procedures involve visual and/or auditory stimuli, then visual and/or hearing impairments may also need to be reported, depending on what is being tested.

EC do not report any of the characteristics of their subjects. They refer to them as "five informants", with no indication of sex, age, or impairments. They do not give the subjects' names, so it is impossible to infer sex. Consequently, there is an additional uncertainty with the data EC provide: it is not possible to determine how the articulatory variation among EC's subjects influenced EC's perception of the location of stress. In contrast, E64 (pp. 19–20) provides some relevant information: the subjects were three males and two females, with ages eighteen, thirty-two, thirty-five, forty, and fifty. No information about the subjects' health is provided.

It is reasonable to be concerned about articulatory variation and impairment in the Mapudungun context. In 2008, the Mapuche were reported to "suffer from poor housing, malnutrition, illiteracy, alcoholism, tuberculosis, and a high rate of infant mortality" (UNPO 2008). It is possible that the same situation existed in 1965, or at least that there were precursors to the problem.

Rates of alcohol abuse and use in many populations are significant (e.g. US: Nace 2005; Australia: AIHW 2007). As alcohol's effects on speech and perception are well established, use of valid tools for evaluating subjects for alcoholism and alcohol intake may well be essential (e.g. Selzer 1971; Babor *et al.* 2001).

Alcohol was chosen arbitrarily here as merely one source of variation in an individual's module. The mere fact that an individual does suffer from alcoholism or acute intoxication of course does not automatically disqualify them as sources of phonological evidence. However, it introduces effects on the perceived speech sounds that must be factored out when determining the PhM's contribution. There are many kinds of individual variation involving

articulators. Even in relatively wealthy, non-marginalized populations, there are often high rates of impairments that can potentially affect speech production. For example, oral pain caused by tooth decay could influence speech production. In the United States, 23.1 percent of all people between the ages of twenty and forty-four had untreated tooth decay (CDC 2008); in socio-economically marginalized groups the rate was much higher (e.g. 'Poor': 39.8 percent; 'Poor Non-Hispanic Black': 48.7 percent).

In fact, it is unclear how many humans *lack* impairment (whether acute or chronic); perhaps they are a small minority of the population. The implication is that if a phonological description does not report impairments of the speaker (or lack of them) there is necessarily uncertainty about whether the analyst's interpretation attended to properties of the speech signal that were controlled by PhM specifications, rather than being caused by neuro-motor or articulatory properties.

5.3.7 The perceptual process

The preceding sections have focused mainly on the speaker. However, most grammars and articles report what analysts perceive the speaker to have produced, so the hearer is an important source of distortion.

The speaker's articulators cause variation in air pressure and flow. However, the subject's articulators are not the only potential sound source. Other speech and machinery can create noise that can distort perception of the speech signal. To minimize such noise pollution, laboratory experiments can use sound-proof booths or enclosures, and fieldwork can be located in quiet rooms. EC do not report where they elicited data, so it is unknown whether background noise interfered with the accurate transcription of some data. Similarly, there is no information about EC's perceptual systems, assuming that their transcription is entirely impressionistic.

Just as with production, each module and mechanism in the perception process provides an opportunity to distort the speech signal. Damage to the ears and hearing mechanism can mean that certain phonetic cues cannot be observed, or that other cues are introduced (and damage is more likely with older people: e.g. Pinchora-Fuller and Souza 2003). For example, partial hearing damage can prevent discrimination among fricatives (Zeng and Turner 1990) and many other contrasts (e.g. Boothroyd 1984).

Perhaps the most important issue is that learning an L1 involves a person's L1 perceptual mechanisms losing the ability to discriminate between certain sounds that do not have a contrastive function (Werker and Tees 1984; Best 1999). Consequently, it may not be possible for a person to reliably discriminate sounds that they do not need to distinguish in their own speech. For example, Peperkamp and Dupoux (2002) report cases where people have

'stress-deafness' – an inability to perceive stress distinctions due to the low functional load stress carries in their L1.

As mentioned in section 5.3.5, stress can manifest itself in many ways. So, the cues an analyst has learned to attend to may not be present or relevant in the subject's speech. Without knowing details about EC's perceptual systems, it is not possible to know which phonetic cues they were attending to, and which they were ignoring.

In fact, Hayes (1995) uses the uncertainty surrounding EC's perceptual systems to cast doubt on certain aspects of their description: "I assume that the prominence heard on final CVC syllables by Echeverria and Contreras is a perceptual effect" (p. 266). (In contrast, Kager 1993: 409 assumes that EC's description of final CVC stress accurately reflects the speaker's intentions.) In other words, EC's perceptual system might have attended to phonetic cues that were not diagnostic of the subject's placement of stress. Hayes's (1995) theory does not allow for CVC syllables to be heavy in this particular case, so the uncertainty about EC's perception raises the possibility of an analysis that differs from their description. Of course, one could observe that most aspects of EC's description could be called into question in the same way: perhaps *all* secondary stress reported was misperceived.

A number of problems with impressionistic transcriptions have become apparent (e.g. in the discovery of incomplete neutralization; Kawahara 2011: §2.2.2 and references cited therein). There are a variety of techniques for avoiding them, involving machine recording and software. However, recording devices and analytical software pose issues analogous to impressionistic transcription. Like ears, microphones are imperfect, and may distort the incoming signal due to limitations relating to directionality, impedance, frequency range, and frequency response. For example, microphones with high impedance will lose high frequencies when used with long cables. All microphones exaggerate some frequencies and attenuate others (frequency response); microphones also differ in which frequencies they can pick up.[7] Like the neuro-auditory interface, digitation mechanisms (e.g. computer sound cards) may distort the signal due to limitations on sampling and frequency range and response. Like the human perceptual mechanism, software generates data structures that can distort the signal, such as pitch trackers inadvertently halving or doubling F0 (Gussenhoven 2004: 5–7). Finally, there is still a human element: the analyst must decide what to attend to and what to ignore in the spectrogram, pitch track, or other measure. E64 (pp. 20–1) reports that the elicitation sessions were recorded and the recordings were used in transcription. However, no information about the recording apparatus is provided.

[7] www.mediacollege.com/audio/microphones/how-microphones-work.html provides an accessible tutorial.

What makes using machines and software potentially better than humans is that it is possible to know exactly how machines distort the incoming signal, while the human perceptual system is still mysterious. However, just like people, machines have a great deal of individual variation. So, without careful specification of which machines, software packages, and analytical methods were used, along with careful attention to their limitations, machine-derived data may be of as little value as impressionistic transcriptions that lack information about the analyst's perceptual system.

Molineaux's (2012) work on the perception of Mapudungun stress is revealing here. Molineaux played two-syllable Mapudungun words to several *non*-native speakers and required them to identify primary stress. For CVCV words, a little over 30 percent reported final stress, while around 50 percent reported initial stress (the remainder did not respond). Such disagreement among different non-native listeners might indicate that the perceptual cues for stress in Mapudungun are quite different, or not as robust, as those in the non-native speakers' languages.

Even so, impressionistic reports and intuitions cannot be dismissed lightly. Hualde and Nadeu (this volume) argue that "[d]ata from intuition are worthy of attention to the extent that they are consistent among speakers of the language". Even if intuitions are a delusion, in some cases they are a shared and consistent delusion, and the source of the delusion might provide insight into phonological knowledge. The problem for Mapudungun is that native speakers seem to not have consistent intuitions about stress: Molineaux (2012) reports that "native speakers were uncertain about stress in disyllables".

Hualde and Nadeu also suggest that intuitions about contrastive (lexical) stress might be more reliable than non-contrastive stress. They observe that there is universal agreement about the placement of primary stress in Spanish but disagreement about secondary stress; primary stress is contrastive, secondary stress is not. However, even if there is universal agreement about some speech property, it is always a significant leap to claim that the property directly reflects a particular aspect of the phonological representation or derivation. I suspect that intuitions are complicated – they can be influenced by the perceptual, lexical, and orthographic systems, and so are unlikely to always directly reflect phonological knowledge.

5.3.8 Expression of the data

The final step for the analyst is expressing the perceived speech sounds in written form. Obviously, the transformation from perceived speech sounds to a phonetic transcription and phonological representation is a hugely complex task. Here, the focus is on the challenges of adapting a description expressed in one theory for use in another theory.

EC express their description in a taxonomic phonemic framework. They do not propose rules in the formalism proposed by Chomsky and Halle (1968), so there is no evidence that they had generative theories in mind.

Translating from perceived speech sounds to a phonemic representation presents many challenges (Harris 1960). Principles of phonemic analysis are applied to determine contrastive sounds, allophonic relationships are identified, and the more basic allophone is selected as the symbolic representation. So, /kúra/ 'stone' is not a generative underlying (or intermediate) form: it is a description of contrastive relationships between speech sounds, with stress also marked. Most of EC's transcriptions are not the equivalent of generative PhM output forms – they do not show allophones. However, EC do provide some allophonic forms, and even phonemic–allophonic pairs: e.g. /ṭómi/ and [ṭʳɔ́mə] 'cloud'; /ïnáy/ and [ɣənái̯] 'he scratches himself' (EC, p. 132).

The challenge for anyone who wishes to use EC's description is to convert it into a form relevant to their theory. In doing so, it is necessary to carefully examine EC's theoretical decisions to see if any information crucial for other theories was removed or altered.

For example, in classical single-level Optimality Theory (OT) candidates are PhM output forms (Prince and Smolensky 2004), and so are roughly equivalent to a (broad) allophonic transcription in phonemic analysis. So, for EC's '/tómï/', the OT winning candidate would not be [t̪ómɯ], but rather the surface/allophonic form [ʈʂɔ́mə].

The pitfalls in using a phonemic description for output-oriented generative theories are illustrated in EC's description of five-syllable words. EC cite /elúaènew/ 'he will give me', and /elúafimi/ 'you will give him' (presumably /elúafìmi/, with secondary stress omitted for expository purposes). However, these forms are phonemic representations. EC's *allophonic* transcription of *eluafimi* is the *four*-syllable "[. . . elu̯áfimì . . .]" (IPA [ɛlwáfimì]). If glide formation is a general process, then the allophonic form of /elúaènew/ would also have four syllables: [ɛlwáɛnɛw]. So, there is a difference between EC's description and its expression in OT: EC's five-syllable phonemic forms must be translated into their four-syllable allophonic counterparts to be used in output-oriented theories. In fact, from the point of view of output-oriented theories, EC cite *no* five-syllable forms. (The only other five-syllable form /l̥aŋïmïwulày/ 'he did not kill himself' has a suffix that interferes with stress placement.)

A more profound challenge of interpretation involves Quantity Sensitivity. EC's General Rule appears to describe a Quantity-Insensitive iambic system: alternating stress without regard to syllable shape. However, for EC stress is only Quantity Insensitive *early* in the derivation. Later in the derivation certain rules have applied that mean that stress apparently becomes Quantity *Sensitive*. For example, EC report the allophonic form "[wəṭʳéimi kái̯] *are you*

cold?" (EC, p. 135). The first word must be syllabically parsed as [wə.ṭʳéi.mi], otherwise stress would be distributed as *[wə.ṭʳé.i.mì]. The same point applies to [mawḯnài]: it must be syllabified as [ma.wḯ.nài], not *[ma.wí.na.ì] (EC, p. 135). With an iambic footing analysis, Quantity-*Sensitive* iambs are necessary to get the right stress: [(ma.wḯ)(nài)], not Quantity *Insensitive* *[(ma.wí)nai]. However, in EC's phonemic analysis there are no CVV syllables when stress is applied, and so no Quantity Sensitivity. Of course, a surface-oriented OT analysis requires evaluation of *output* forms. So, to have [(ma.wúɩ)(nài)] beat *[(ma.wɯ)(na.ì)], an analysis that treats CVV syllables as heavy is required. In short, while EC's phonemic theory allows them to treat stress as Quantity Insensitive (at least in the early derivation), OT requires the same system to be analyzed as Quantity Sensitive.

Of course, the preceding discussion assumes that EC's allophonic transcriptions accurately represent the PhM output form after all phonological processes have applied; they might in fact show derivationally intermediate forms, or describe Phonetic Module representations, or show the application of optional processes.

A thorough evaluation of a source must address the issue of what the source did not mention and why. A description's silence about a phonological property does not mean that the subjects failed to exhibit the property. A common example of inadvertent omission is secondary stress. Many descriptions do not mention secondary stress at all, even to deny that it is present: even casually browsing through the UD Phonology Lab Stress Pattern Database emphasizes this point – many entries note that the lack of secondary stress is "deliberately ambiguous between 'none reported' in a source and 'verifiably none'" (Heinz 2012). Gordon (2000) documents several cases of default-to-opposite stress systems where a source's silence about secondary stress was incorrectly interpreted to mean that it did not exist.

Secondary stress presents a particularly difficult problem because it seems to be far more difficult to perceive than primary stress. If so, primary stress descriptions might be more reliable than secondary stress descriptions. (It is also possible that rhythmic secondary stress might be easier to perceive than non-rhythmic secondary stress, such as secondary stress on initial or final syllables). EC did report secondary stress; however, without knowing how secondary stress is phonetically realized or how other phonological processes are affected by it, we cannot be sure that EC correctly reported all secondary stresses, or were even correct in identifying the secondary stress they did. Notably, E64 did not distinguish primary from secondary stress in his transcriptions.

In some cases, omissions are deliberate and are driven by theoretical concerns. For example, a stress theory that does not allow for more than two

word-stress distinctions (primary vs. secondary) could lead to describers not reporting tertiary stress. EC's description is an interesting case because the theoretical goal for stress seems to have been to provide a rule for it rather than account for the distribution of stress in surface forms. Since the rule appears derivationally early in their analysis, later rules that significantly obscured the earlier assignment of stress (e.g. glide formation) were omitted from the description, along with the actually attested surface form of words.

The general point is that converting a description into a form that is useable for a generative analysis is not a trivial task. If a source is expressed in a different framework (e.g. taxonomic phonemics), then repurposing it for a generative analysis can be fraught with danger. In fact, if a source does not supply output forms, then it has limited worth for output-oriented theories: even when there is explicit description of phonological processes, lack of output representations introduces uncertainty as to whether all relevant phonological processes have been described. For example, EC does not mention glide formation or the processes that lead to vocalic diphthongs; their existence was deduced from their allophonic transcriptions. So, from the point of view of an OT analysis, EC does not provide the right kind of data: their theoretical view transmutes the data in a way that it is difficult to derive PhM outputs – i.e. the kind of data that output-oriented generative theories require.

Hyman (this volume) notes that descriptions and analyses are theory-dependent; there is no way to present a theory-neutral description of stress. So, EC did not make a mistake by expressing their description in phonemic theory; it was inevitable that it must be expressed in *some* theory. In fact, recognizing the role of theories in description is valuable: it allows us to squarely face the issue of translating the description's theory into a generative one. Of course, some (perhaps all) theories end up expressing the data in such a way that properties that are crucial for other theories might be obscured. For example, if one wishes to express a stress description in a theory that has culminativity, then necessarily one of the stresses in a domain must be described as the 'primary' one, even if there is no evidence for that claim. The description then becomes misleading for use in a theory without culminativity. In the most extreme cases, it might not be possible to adapt a description expressed in one theory for use in another theory.

5.3.9 Replication

Replication of stress descriptions is not required by any aspect of the theory. However, given the opportunity for errors at so many stages in the evidence gathering and expression process, replication can provide a way to increase

confidence in the results. In the field of psychology, the issue of replication and the consequences of lack of replication have received a great deal of attention recently: Hartshorne and Schachner (2012) advocate tracking experiment replication; Sutton (2012) is a journal issue devoted to replication; and there is a list of twenty psychological experiments that people would most like to see replicated at http://psychfiledrawer.org/top-20/.

Data replication for the generative phonologist would involve eliciting the same forms from the same PhM. So, for every elicitation/experiment involving a person's PhM, the same elicitation/experiment would have to be performed on that person's PhM. Less ideally, the same elicitation/experiment could be performed on a different person, as long as a strong case is made that the individual had a PhM that was identical to the original subject's in relevant respects. The replications should also not be greatly separated in time otherwise the subject's PhM might change, or other production mechanisms might degrade significantly.

A far less ideal data replication would be for the same elicitation/experiment to be performed on a subject who speaks the same 'language' as the original subject. It is a less ideal situation because 'language' is an irrelevant concept for generative theories: it is a socio-political idea with a tenuous relationship to the object of study: i.e. the linguistic cognitive modules. The group of people who say that they speak the same language can have vastly different PhMs, even to the point of mutual unintelligibility. So, words elicited from a Mapudungun speaker in 1965 cannot be assumed to have any cognitive relevance for the same words elicited from a Mapudungun speaker now. In this sense, then, EC's description cannot be replicated – if they used the same subjects as E64, it is likely that some of them will now be deceased. For the others, they will be significantly older, and their Mapudungun PhMs may have changed or not been used over the past several decades. In fact, it is possible that too much time has elapsed to be confident that there is any person with a PhM that is identical to the original speakers.

However, as potentially problematic as replications involving different subjects can be, for stress descriptions they are the only type of replications available, so let us consider them valid replications for the sake of this discussion.

Stress descriptions used in metrical work are typically unreplicated. Of Gordon's (1999) list of 392 metrical systems (i.e. 'languages'), 272 (69 percent) were listed with only one source and therefore unreplicated (assuming that Gordon's 1999 bibliography is comprehensive). Of the remaining 120 languages, it was unclear how many of the later descriptions involved re-elicitation of the same data as the original description – the number of replicated descriptions may therefore be much lower than 31 percent.

Mapudungun is in the minority: there have been several recent descriptions of its stress patterns, including E64, and the grammars of Smeets (1989), Salas

(1992), and Zúñiga (2000, 2006).[8] EC was published in 1965, whereas the other grammars came decades later, so it is highly unlikely they had the same subjects as EC. It is therefore quite possible that all the grammars describe distinct PhMs, in which case considering them to be replications of EC's description is incorrect, and comparing them would reveal nothing of value. With this caveat in mind, let us assume that the grammars' subjects did have identical PhMs.

There is a great deal of disagreement among the four descriptions. For example, for CVCV words, EC describe lexical stress (or free variation), Smeets (1989: 60) a tendency for initial stress, Salas (1992: 83) free variation, and Zúñiga (2006: 64) a tendency for final stress. For main stress, EC describes it as falling on the second (peninitial) syllable, while Salas and Zúñiga have it fall on the final syllable if it is closed, otherwise the penult; Smeets locates it on the second syllable, except in five-syllable words where it falls on the penult, and describes long words as having two primary stresses.

For secondary stress in polysyllables, EC have secondary stress on every even-numbered syllable after the main stress (e.g. /kimúfalùwulày/ 'he pretended not to know'). Smeets says that every second and every final syllable has secondary stress (e.g. [allkḯpenuèl] 'unheard of'; Smeets 1989: 60). Zúñiga (2006: 64) describes secondary stress as falling on the first or second syllable, depending on which one is closed (e.g. *kàmapuléy* 'it is far', *weyùlküléy* 'it is swimming').

Trisyllables of the form CV.CV.CVC illustrate the extent of disagreement well: EC CV.CV́.CV̀C (e.g. /θuŋúlàn/ 'I do not speak'), Smeets CV.CV́.CVC (e.g. [kuñífal] 'orphan'; 1989: 60), Zúñiga CV.CV.CV́C(e.g. *machitún* 'healing ceremony'; 2006: 64), and Salas CV̀.CV.CV́c (e.g. *à-cha-wáll* 'chicken'; 1992: 84).

There are some similarities. For example, all sources agree that CVC syllables attract stress in some situations: e.g. all agree that stress is final in CV.CVC words.

It is quite possible (even likely) that all the sources were describing different PhMs, so the fact that they disagree is not proof that EC's description is inaccurate. However, at the very least the differences between the sources mean that EC's results have not been replicated.

An interesting comparison is E64 and EC, since they apparently used the same recordings, and were therefore describing the same PhMs. However, there are analytical differences between the two descriptions. E64 (p. 48) states "El acento no es predecible fonémicamente, pero sí podría serlo en un plano morfémico, es decir, atendiendo a cierto tipo de morfemas". ['Stress

[8] Augusta (1903: 2–4) is so far removed in time from the recent grammars it will not be discussed here (see Echeverría 1964: 46ff. for comments).

is not phonemically predictable, but could be on the morphemic plane – i.e. influenced by certain types of morphemes' – my translation], and adds that certain morphemes probably have fixed accent, citing /rumé/ 'quite' and /wulé/ 'tomorrow'. E64 (pp. 47–8) also reports the result of a perceptual experiment where the speaker judged both [umau̯tulén] and [umáu̯tulén] to be acceptable; the speaker rejected forms with initial and third syllable stress. It is surprising that [umau̯tulén] was accepted given that EC describe primary stress as falling on the second syllable (p. 134.c2) (cf. /elúmuyù/ 'give us'; p. 134.c2). In fact, E64 makes no distinction in transcriptions between primary and secondary stress: e.g. /féytɯfá/ 'este'/'this' (p. 54), /l5aŋúmúm5/ 'matar'/'kill' (p. 55).

E64 (pp. 54–5) also provides transcriptions of 107 words and 43 phrases, with stress marked. When comparing the data with EC's, the same general results emerge for disyllables: CVCV words have mostly initial stress, CVCVC words have final stress, and CVCCVC words tend toward final stress.

(8) *Disyllable stress in Echeverría (1964: 51–54)*

Shape	Initial stress	Final stress	Both	Total
CV.CV	27 (96%)	1 (4%)	0	28
CV.CVC	0	32 (97%)	1 (3%)	33
CVC.CV	4 (57%)	2 (29%)	1 (14%)	7
CVC.CVC	0	6 (100%)	0	6
ALL	31 (46%)	41 (55%)	2	74

However, in trisyllabic words E64 has several disagreements with EC's description. EC state that CV.CV.CVC words have penultimate primary and final secondary stress (e.g. /θuŋúlàn/ 'I do not speak'). However, E64 marks stress on final syllables: /aliwén/ 'tree', /ɯnatún/ 'bite', /weyelúm/ 'swim', /nɯtamkán/ 'say', except for two words, /l5aŋúmúm5/ 'kill', /umáwtún/ 'sleep', which have equal stress on both penult and final. In agreement with EC, the second syllable is stressed in /fɯtáŋma/ 'large' and /mawíθa/ 'mountain', but other stress patterns given are /fɯtáŋmá/ 'long' and /féytɯfá/ 'this'. Only one word longer than three syllables is given: /tɯlkéaliwén/ 'peel, crust', and this stress pattern does not fit with EC's description of alternating stress (i.e. it should be */tɯlkéalíwen/).

5.4 Levels of acceptability

The aim of the preceding section was to use the theories of generative phonology and other modules and mechanisms to identify possible sources of distortion of the PhM output on its path from the speaker to the analyst's description. There are many more conditions and other modules and mechanisms that should be examined (e.g. limitations on memory and attention). However, this section

discusses the more practical issues of levels of acceptability and responsibility for evidence evaluation.

Until phonological outputs can be detected directly, all evidence will have some potential for non-PhM distortion, and so carry some degree of uncertainty. So, the challenge is not to achieve perfect evidence, but to decide how much uncertainty can be tolerated.

There is an objective and a subjective aspect to evaluating evidence. The objective side is that theories of speech production and perception identify places where distortion of the speaker's PhM output occurs. So, no list of evidentiary requirements can be merely prescriptive; each requirement must be shown to derive from a principle of the theory. For example, requiring that the eye color of the consultant be reported cannot be justified by any relevant theoretical principle (I know of no research that links eye color to production or perception). In contrast, controlling for speech-style shifts is crucial, as the theory has different PhMs (or PhM states) for each different speech style.

The subjective side is determining an acceptable level of uncertainty for any data. At what point does uncertainty mean that a description cannot be used as evidence? Are there certain points that are non-negotiable? For example, does data pooling mean that the description cannot be used?

I am not aware of any current consensus about minimal requirements for evidence in the field of phonology. Perhaps lack of explicit discussion and publication of such standards is hampering – or even thwarting – progress in the field. After all, if this chapter's exploration of EC's description occasions any pause among metrical theorists, then similar issues may well arise for many other commonly cited sources. It may well be worthwhile to require publications to explicitly evaluate any source used as evidence, or start to accept articles for publication whose sole aim is to evaluate the degree of certainty for a source.

Certainly, whatever the standards are that currently exist or develop, they must be reviewed frequently and allowed to change. Standards of acceptability change over time as theories, methods, and technology develops. The dominant paradigm for description in 1965 involved phonemic analysis, with the goal of determining phonemic forms. Stress (and other phenomena) could be described as applying to phonemic forms, so there was often no theoretical motivation for providing extensive allophonic forms (just as in EC's description). In contrast, the focus of generative theories involves identifying transformations from underlying to surface forms, so descriptions must provide underlying forms, transformations, and surface forms (e.g. compare EC with Parker 1999). Particularly for descriptions expressed in output-oriented theories, the phonological output must be provided. Theories of the Phonetic Module emphasize speaker-specific variation (e.g. Kingston and Diehl 1994), and so the need

for teasing apart phonetic and phonological contributions to perceived speech sounds has become apparent. There is also greater understanding of cognitive and articulatory individual variation and trauma, and it is far easier to record and machine-analyze speech today than it was in 1965. It will no doubt become even easier in the future (e.g. cheap and easy palatography, ultrasound, and nasal airflow measurement would be very useful), and hopefully techniques will develop that will eliminate much more of the uncertainty that still exists currently. It is therefore important to be frank about our current best capabilities; they are far from certain because no technique provides a clear picture of the PhM at work. It is probably inevitable, then, that even the best of the most recent descriptions will one day be considered inadequate evidence.

So, while EC's description in 1965 was probably as good as a generative phonologist could have hoped for, the only relevant question now is whether EC's description remains reliable and relevant given current expectations. As the preceding section suggested, with all the developments of the past half-century, EC's description now has a very uncertain status as evidence for a generative theory.

One way to approach development of evidentiary standards is to try to codify the most stringent requirements that reviewers place on journal articles. For example, I suspect there is a consensus that a phonological description based on primary fieldwork should include information about the subjects (e.g. sex, age, perhaps native-speaker status), and that there should be at least some phonetic analysis – I suspect that impressionistic transcription (at least for some properties) may nowadays be less frequent in journal articles, or at least reports of phonetic analysis are more common (see Rice's 2011 section on 'Language Documentation' for relevant references).

The great danger is that requirements will be explicitly or implicitly imposed that are not derived from a theory. For example, while literature on language documentation and fieldwork proposes a number of desiderata for subjects and descriptions, evidence requirements are not often shown to derive from a theory; they are often prescriptive or cater to non-theoretical needs as the goals are often to document languages for social purposes (e.g. Crowley 2007). For example, Rice (2005) and Noonan (2005) identify a number of properties of "good [descriptive] grammars", observing that grammars have many different audiences apart from generative linguists, and roles other than providing evidence for generative theories. So, their proposed desiderata are not derived from generative theories, but rather seek to address the conflicting demands of the description's readership. Cheliah and de Reuse (2011: chapter 7) present an extensive discussion of the ideal fieldwork subject. Many of their criteria are similar to those required in generative work. However, it is not clear from what principles their criteria derive; it seems that there is in part a sociological aspect

to their proposals as they imply the goal is language documentation (rather than determining possible states of cognitive modules).

The final issue is responsibility for evaluation. At no point was it suggested here that Echeverría and Contreras failed in their task because they did not address particular issues such as the speaker's impairments, and so on. In fact, no part of the preceding discussion was – or should be read as – a criticism of EC's description. It instead advocates the view that evaluating a source is an essential part of using it as evidence for a theory. However, who is responsible for evaluating sources?

The source's author cannot be held responsible. EC did not necessarily have modern generative theories in mind when they wrote their description, and so it is impossible to fault them for not addressing issues that arise from generative theories. Responsibility must fall on the theoretician who repurposes EC's description as evidence for their theory. So, if I cite EC's description as evidence for a metrical theory set in OT, it is incumbent on me to show that EC's description is accurate and relevant for its new use as evidence for my theory. Even if the description is set within the same theoretical framework as my theory, it is still necessary to demonstrate that the description is accurate and relevant; adoption of evidence necessarily places responsibility for evidence evaluation on the adopter. In other words, it is not EC's failure that they did not report their subjects' native-speaker status, or that they pooled their data; it would be my failure if I used their description for my theory when my theory required subjects to be native speakers and to not pool data.

Perhaps part of the problem relates to perception of the status of descriptions such as EC's. Articles that cite sources without providing a detailed evaluation of them are assuming that the description is not only a fact, but a generative fact. However, descriptions are merely hypotheses for which (hopefully) adequate and relevant evidence is available. The first questions for any theoretical work that cites a source, then, are whether the source's description can be recast as a hypothesis in that theoretical framework, and whether there is evidence for the hypothesis.

The larger problem touched on here is that recovering information about the output state of a deeply embedded cognitive module from data that has undergone multiple metamorphoses is incredibly difficult (Chomsky 1965: 18–19, 1971: 130). Currently, there is no way to detect phonological inputs or outputs directly, and at least in some cases the procedures that are used have not been proven to be valid. It is to be expected, then, that if any description is presented as evidence for a generative theory, it should be accompanied by an extensive justification for its use.

A potential concern is that if the bar is set too high for evidence, particularly for stress, there will be no evidence left and so no way to evaluate theories. However, this concern may be unwarranted; without a thorough review of the

evidence and concrete proposals about evidentiary standards there is no way to know which cases meet what standard. In any case, I do not fear discovering that we cannot have confidence in the majority of evidence cited for phonological theories. What I do fear is that significant generalizations about PhMs have been missed and theoretical development has been derailed because inadequate, irrelevant descriptions have been assumed to be valid evidence.

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6 Convergence of prominence systems?

Keren Rice

6.1 Introduction

Haas (1976: 347) remarks: "It is by now well-accepted that languages of the same geographical area may come to resemble each other in a variety of ways and hence it is clear that it is just as important to delineate areal resemblances as it is to depict genetic resemblances."* Thomason and Kaufman (1988), in their seminal work on language contact, argue that contact can lead to language change in any part of the grammar, including prosodic systems.

In fact, some have argued that prosody is particularly vulnerable to spread in contact situations. Matras (2009: 231) makes the following statement: "Prosody seems to be more prone to cross-linguistic replication in contact situations than segmental phonology, with stress figuring in-between the two. The position of tone – which shows a high tendency toward areal clustering – may be considered somewhat problematic since it correlates strongly with the morphological typology of languages and so with internal diachronic developments. But tone too appears to be related to prosody (intonation and stress) in its contact susceptibility."

North America offers a valuable testing ground to study the spread of linguistic features under conditions of language contact. There are a number of established linguistic areas in North America; see for instance Campbell (1997), Mithun (1999), and Golla (2011) for discussion. In addition, an unusual feature of North American prosodic systems is noted by Hayes (1995: 269): "Note

* Versions of this work were presented at the workshop Word Accent: Theoretical and Typological Issues held at the University of Connecticut in spring 2010, at the Phonetics/Phonology Workshop held at the University of Toronto in fall 2010, at the University of California Berkeley in fall 2010, and at Yale University in spring 2012. Many thanks to the members of those audiences for much food for thought that, I hope, improved this work. Thank you also to the two reviewers of this chapter, and to Harry van der Hulst for inviting me to the workshop on word accent, providing me with the opportunity to think more systematically about this material than I had previously, and for very helpful feedback. This research is supported by the Canada Research Chair in Linguistics and Aboriginal Studies to Keren Rice.

finally the curious generalization that most iambic languages are (or were) spoken in the Americas. Given that Dryer 1989 has argued that typological similarities can extend over linguistic areas that comprise entire continents (including, for example, the Americas), this geographical asymmetry may not be a coincidence. On the other hand, throughout the Americas the iambic languages are interspersed with great numbers of non-iambic languages, so the idea that iambic stress is an areal phenomenon of the Americas should not be taken as a certainty."

Given Hayes's observation, an interesting question arises: Have prosodic systems in languages of America come to be more similar through contact? And, if so, just what is the effect of that contact? Contact clearly leads to the borrowing of words and of sounds. Contact-induced change (e.g. Thomason and Kaufman 1988) involves change in a language that has contact as one of its sources – with change occurring that would be less likely outside of the contact situation. Borrowing of words and sounds is a clear case of change through contact. What about other change? Mithun (2010: 673) notes that "Of particular interest are similarities of a type that might seem unborrowable, patterns of abstract structure without shared substance". Mithun is referring to properties such as the distribution of agent/patient systems and the propensity for lexical suffixes in some linguistic areas. Aikhenvald (2006: 15) makes a similar observation, noting more generally that "Borrowing patterns does not presuppose borrowing forms".

In this chapter, I begin with a study of prominence in loanwords from a European language to an indigenous language of North America to establish that prominence is borrowable, as Matras (2009), Thomason and Kaufman (1988), and others argue. I move from the borrowing of words from European languages to an investigation of the adaptation of patterns from European languages, as suggested by Aikhenvald (2006) and Mithun (2010). We will see that patterns of prominence appear to be borrowable from the source language to the recipient language independent of particular lexical items. I then address prosody in some of the linguistic areas of North America to see what we can learn about prosodic systems in these areas, and whether prominence is indeed a pattern that is likely to be shared through contact-induced change.[1] It turns out that there are many questions that must be asked, and answers are often somewhat elusive.

In the following discussion I use the terms 'prominence', 'prosody', and 'accent' largely interchangeably to refer to specific effects of both stress and tone, and 'tone/pitch' and 'stress' for more realizational phenomena.

[1] See Goedemans and van der Hulst (this volume, Figure 4.4) for a map showing the location of languages in North America.

6.2 Loanwords and accent systems: loanwords from settler languages

I begin with a study of prominence in loanwords in native languages from post-contact settler languages. It is well known that changes often take place in words when they are borrowed from one language into another, generally to make them more similar to the borrowing language in their phonology; see Kang (2010, 2011) for recent overviews.

With respect to prominence, there are different possibilities for what might occur when a word is borrowed. First, prominence in the source language might be interpreted as prominence in the recipient language, potentially introducing a new prosodic pattern into the recipient language. Second, prominence in the source language might be ignored, with the pattern of prominence in the recipient language holding sway. Finally, some amalgam of the two systems might result. I examine these alternatives in turn. See Kang (2010) for recent discussion.

6.2.1 Borrowing of prominence in the loanword lexicon

First consider cases where prominence in the recipient language is interpreted faithfully with respect to the source language. In the cases illustrated here, prominence, realized as stress in the source language, is realized as tone in the recipient language.

6.2.1.1 Navajo (Athabaskan)

The first example comes from loanwords in Navajo (Athabaskan) from Spanish (1a) and from English (1b). The vowel that is stressed in Spanish and English has high tone in Navajo, and is often lengthened; the conditions under which lengthening takes place are not clear. Data is from Young and Morgan (1987: 7 [grammar]). I use Navajo orthography; ‘´’ marks high tone, while low tone is unmarked. The stressed vowels in Spanish and English are underlined.[2]

(1)		Navajo	source language	
		Navajo	Spanish	
	a.	bilagáana	Americ<u>a</u>no	‘white man’
		géeso	que<u>s</u>o	‘cheese’
		bilasáana	manz<u>a</u>na	‘apple’
		gohwééh	café	‘coffee’
		golchóón	colch<u>ó</u>n	‘quilt’

[2] I do not know why, in the data in (1), there is high tone on just the first vowel of a long vowel in some cases and on both vowels of a long vowel in others.

b. Navajo	English	
jélii	jelly	'jelly'
késhmish	Christmas	'Christmas'
Wáashindoon	Washington	'federal government, government'
gáaboleita	carburetor	'carburetor'

The position of primary stress of Spanish and English is maintained in the loans in Navajo, being interpreted in Navajo as high tone, frequently with lengthening of the vowel. To my knowledge, there are no principles of Navajo itself that would predict this placement of prominence; this thus appears to be a case of maintaining the prominence pattern of the source word in the recipient language, interpreting it as a prosodic feature already present in the recipient language, namely tone.

6.2.1.2 Tłı̨chǫ Yatiì (Athabaskan)

This type of adaptation of the phonetics of prominence, retaining the position in which it occurs in the source language, is found in other cases. I consider next another Athabaskan language, Tłı̨chǫ Yatiì (also called Dogrib), spoken in the Northwest Territories, Canada. Spelling is used (note that the hook below a vowel represents nasalization); all data is from Saxon and Siemens (1996). The source language words are French, although it is possible that these did not enter the language directly from French but via other indigenous languages or Métis French (see, for instance, Bakker and Papen 2008: 259–61 for discussion).

(2)	Tłı̨chǫ Yatiì	French	
	lìgodǫ̀	le cotton	'cotton, cotton fabric'
	lìsimı̨̀, lìsimą̀	l'essui-main	'towel'

Where French has final stress (underlined vowel), Tłı̨chǫ Yatiì has a low tone (ˋ) on the final vowel. Low tone is considered to be the 'marked' tone in Tłı̨chǫ Yatiì: for instance, there are morphemes that consist of a tone alone in Tłı̨chǫ Yatiì, and this is a low tone (see Rice and Hargus 2005, for instance, for discussion of tonal markedness in Athabaskan languages). Thus in Tłı̨chǫ Yatiì, as in Navajo, the source language stress is adapted into the recipient language, with a phonetic realization that is salient in the recipient language.

6.2.1.3 Mohawk (Iroquian)

In Mohawk (Iroquoian) too there are loanwords from French. Mohawk has penultimate (or antepenultimate, if conditions for epenthesis are met) stress; see Michelson (1988) and Mithun (1999). French loanwords, on the other hand, have final stress, written with an acute accent, sometimes accompanied by falling tone, written with a grave accent. Data is from Mithun (1999: 313).

(3)	Mohawk	French	
	rakeréns	la grange	'barn'
	rakaró:t	la carotte	'carrot'
	timotón	des moutons	'sheep'
	akarè:t	la galette	'cake'

Thus, while the position of stress in Mohawk is predictable, the loanwords do not adapt to this stress pattern, but take the final stress of French.

6.2.1.4 Tunica (isolate)

While in many languages the position of prominence in the recipient language is identical to that of the source language, in other languages this is not the case, with the loans integrated into the recipient language in terms of the position of prominence. Tunica (isolate) is an example of such a language. Tunica has loans from French, as discussed by Haas (1947).

(4)	Tunica	French	
	ˈkafi	café	'coffee'
	ˈʃawana	chinois	'Chinese'
	ˈminu	minon	'cat'

Haas notes that Tunica has word-initial stress. Despite the word-final stress found in French, Tunica adapts the stress pattern to fit the Tunica pattern.

6.2.2 Borrowing of prominence patterns in the loanword lexicon

The languages discussed so far show, not surprisingly given patterns from languages around the world (see, for instance, Kang 2010 for discussion), that prominence patterns of the source language vocabulary may be maintained in loanword adaptation, or that they may be adapted to the prominence pattern of the recipient language.

The next example appears initially to be identical to the former group, with the prominence pattern of the source language maintained in the recipient language. The examples in (5) are from Dene (also Slavey, Athabaskan; Rice 1989: 200–1). The pattern is like that of the closely related Tłı̨chǫ Yatiì, except that it is high tone that is marked; recall that the hook beneath the vowel marks nasalization.

(5)	Dene	French	
	líshabú	le chapeau	'hat, cowboy hat'
	líbahdú	le bateau	'barge'
	lísaldá	le soldat	'police'
	lígodǫ́	le cotton	'cotton'
	lidí	le thé	'tea'

In these cases, the loanword has a high tone on the final syllable, the same position in which stress occurs in French. There is also a tendency to place a high tone on alternating syllables prior to this. I do not address this non-final tone here.

The next set of Dene data reveals an interesting pattern. In Dene, word-final consonants are either neutralized to [h] or are lost. Words that are consonant-final in French are adapted segmentally in one of two ways. They may end in a consonant other than [h], violating Dene phonotactics. Alternatively, they may take an epenthetic final vowel, preserving the final consonant of French. (The facts are somewhat more complex; see Rice 1989 for discussion). In either case, the final vowel of the word has a high tone. Both patterns are illustrated in (6).

(6)	Dene: C-final	Dene: V-final	French	
	ligár	lígarí	les cartes	'cards'
	lishár	lísharí	le char	'truck, wheelbarrow'
	líganár	ligánarí	le canard	'large kettle'
	ligaryól	lígariyolí	la cariole	'carriole'

These patterns are in variation; one and the same speaker may use both forms. The prosodic pattern of the source language, final stress, is maintained in these words (as high tone), rather than maintaining prominence on the vowel itself that is stressed in French. Thus, we find a word like *lígarí*, with high tone on the final vowel, rather than *ligári*, maintaining the position of prominence found in French.

There is little internal evidence that I know of from Dene itself that would suggest that a final vowel would have a high tone. In terms of morphology, there is a possessive suffix that is used to mark that a word is a morphological or syntactic dependent in some way. This suffix has the form *-é*, a vowel with a high tone, or simply a high tone. There is also a suffix *-e*, sometimes *-i*, although this suffix is generally lexicalized with certain words. Could the final vowel in the Dene loanwords be treated as a suffix? To my knowledge, there is no evidence for there being word-internal morphology in the loanwords. While the loanwords can add a high-toned vowel, with the tone perhaps making the final vowel similar to the possessive suffix, the possessive suffix is not expected with morphologically simple words.

The language also has stress (see, for instance, Rice 2005), realized as intensity, with stress on the stem vowel in nouns. It is not obvious how to identify the stem in loanwords – in the native lexicon, the stem generally is the final syllable of the word except when one of the suffixes noted above is present. Another analysis might be that the final vowel in loanwords is treated as the stem vowel, with the stem stress realized as tone.

Loanwords from French are identifiable in other ways – they begin with *le* or *la*, a pattern that is found only rarely in native lexical items (*lamǫ* 'ring', a compound, literally *la* 'finger' + *mǫ* 'around'). Is the presence of *la/le* in loanwords an indication that these words are treated as morphologically complex, making the possessive suffix a possibility? This does not seem likely, given that this final vowel is only a possibility when there is a consonant present in French; it does not occur with vowel-final words, even though certain vowel sequences are allowed (e.g. a-i) in the language.

None of the above attempts at explanation for language-internal sources of the final high tone in French loanwords in Dene are very persuasive. It appears that Dene speakers borrowing these French words did not build on native language patterns, but rather created a loanword pattern that assigns high tone to the final syllable of a loanword from French, drawing on the French pattern of final stress.

6.2.3 Summary

To summarize, many North American indigenous languages have loanwords from settler languages. In these loanwords, the position of prominence may be borrowed directly, perhaps realized phonetically in a different way in the recipient language than in the source language (e.g. interpreted as tone instead of as stress), or adapted to the system of the language. The examples from Dene are particularly interesting, and form a bridge to the discussion in the following section: in this case it appears that the French pattern of final stress is what is borrowed as a blueprint for French-origin loanwords, a class that is not difficult to identify.

Part of the goal of this chapter is to set out some of the issues that arise in studying the borrowing of prominence systems under conditions of contact, and I end this section with remarks on this topic. The studies presented in this section strike me as clear cases of the direct borrowing of source language prominence in loanwords. However, often the information presented in the literature is inadequate to provide an analysis of what happens in the loanword situation. First, there is often insufficient information about the prominence system of the recipient language to know whether the pattern from the source language is adapted or not. Second, it is not always clear what the prominence patterns in the source language are, even with languages such as French and English, as the words may not be borrowed directly from that source language, or from a 'standard' dialect. Third, I discussed whether the final vowel in Dene might be a suffix or whether the words might be treated as morphologically complex in some other way. While the presence of the final vowel in Dene is phonologically conditioned, there is not often discussion of the morphological

structure of loans in the languages with complex word structure, and it could be that there are language-internal factors that might predict the placement of prominence if the structure of the loanwords were understood. Finally, there is often inadequate socio-historical information about contact – how words were borrowed, the type of contact, and other such factors that are clearly important in language contact (see, for instance, Thomason and Kaufman 1988 and Kang 2010 on loanwords).

Despite these challenges, there are conclusions about prominence in loanwords in the languages surveyed. First, the phonetic realization of prominence may differ in the source and the recipient languages (e.g. Navajo, Dene). Second, speakers of a language may keep the prominence of the source language word (e.g. Navajo, Mohawk), or they may alter it, to fit a native prominence pattern (e.g. Tunica). And, finally, when segmental adjustments occur in the recipient language, the prominence *pattern* of the source language may be maintained rather than the position of prominence in the source language (e.g. Dene), suggesting that an abstract system can be borrowed.

6.3 Borrowing of accent systems from settler languages

I now turn from the borrowing of words to the borrowing of systems. Recall from section 6.1 the claim in the literature on contact that prosodic systems are readily borrowed. The Dene case examined in section 6.2.2 suggests that a pattern can be borrowed and applied to loanwords. Can a pattern be borrowed and generalized to the native vocabulary of a language? In this section I examine examples of this sort.

6.3.1 Stoney (Siouan)

The stress of Stoney (Siouan) is discussed in detail by Shaw (1985). Stoney is closely related to Dakota, a language that generally has second syllable stress. See Shaw (1985) for detailed discussion and analysis. Stoney too exhibits second syllable stress, as in (7). I have modified Shaw's marking of stress from an acute accent to the IPA symbol.

(7) Stoney
a ˈkida 'look at it'

Longer examples reveal that Stoney not only has second syllable stress, like its close relative Dakota, but it also has a right-edge-oriented stress system. In particular, if the final syllable of a word is closed by a single consonant, there is penultimate stress as well as stress on the second syllable, as in (8) (Shaw 1985: 189).

(8) [[a,kiˈda]$_{II}$-kta-č]$_{III}$ 'he will look at it' (look at-FUT-DECL)
[[a,kida]$_{II}$-ˈbi-kta-č]$_{III}$ 'they will look at it' (look at-PL-FUT-DECL)
[[ak,ida]$_{II}$-bi-ˈsį-kta-č]$_{III}$ 'they will not look at it' (look at-PL-NEG-FUT-DECL)

If, on the other hand, the word ends in a consonant cluster, then there is stress on the word-final syllable as well as on the second syllable, as illustrated in the examples in (9).

(9) [[a,kida]$_{II}$-ˈbi-n-č]$_{III}$ 'they looked at it' (look at-PL-PERF-DECL)
[[a,kida]$_{II}$-bi-ˈsį-n-č]$_{III}$ 'they didn't look at it' (look at-PL-NEG-PERF-DECL)
[[wį,ča-ya-khuˈde]$_{II}$-n-č]$_{III}$ 'you shot them' (them-you-shoot-PERF-DECL)

Shaw (1985) argues that the second syllable stress represents the pattern that derives from Siouan, while the ultimate or penultimate stress arises due to contact with English. More specifically, Shaw (1985: 191) says: "What the metrical analysis advanced here permits, however, is the recognition of the undoubted relevance of a major language-external factor. Specifically, the basic parameters of the SSR [Stoney Stress Rule] foot construction and consonant extrametricality formulated for Stoney in (30) are virtually identical to those postulated in Hayes' (1982: 238) analysis of the English Stress Rule. This identity is surely more than fortuitous. Given that Stoney is a minority language embedded in a dominant and pervasive English milieu, it is eminently reasonable to conclude that Stoney has simply borrowed the English Stress Rule. Like all innovative phonological processes, the SSR/ESR was incorporated at the end of the grammar . . . "

Shaw formulates the Stoney stress rules as in (10).

(10) Stoney stress rules (Shaw 1985: 189)

C-Extrametricality: [+cons] ➔ [+ex]/__]

Foot Formation: Starting from the R-margin, construct a maximally binary foot on the rhyme projection. Label sister nodes Left is Strong. (Universal Constraint: recessive nodes cannot branch) Domain: Level III

Word Tree: Incorporate all feet and any left-over syllables into an R-branching tree. Label sister nodes R is Strong.

In this case, the system of English was added to the already existing Dakota stress system in Stoney, independent of the borrowing of words themselves.

6.3.2 Michif

Michif (Algonquian/French) is a well-known example of a language that combines elements of two languages, in this case Cree and French. Michif is generally characterized as having Cree verbs and French nouns (e.g. Bakker

1997; Papen 2003). I draw the following discussion from Rosen (2007). Rosen compares the stress systems of Cree, French, and Michif. Using a parameter-based model, Rosen characterizes French stress as falling on the final syllable at the word level. The Cree system is more complex. Iambic feet are built from the right edge, with the rightmost foot being extrametrical. In Rosen's system, this foot is ignored for the purposes of assignment of primary stress, with primary stress on what would be the penultimate foot, although the final foot can receive secondary stress.

Rosen (2007: 232) argues that Michif has iambic feet built from the right edge and a rightmost extrametrical foot, like Cree. Cree and Michif differ, she argues, in terms of another parameter: strong syllables must branch in Michif but not in Cree. Both languages parse degenerate feet; they can receive primary stress in Cree but not in Michif.

In two-syllable words, stress is final in all three systems, as in (11) (Rosen 2007: 232). I give Rosen's structures for the three languages, with examples for the Michif pattern.

(11)

Cree	French	Michif	
Wd	Wd	Wd	
|	|	|	
F_s	F_s	F_s	
⋀	⋀	⋀	
w s	w s	w s	
(x x́)	(x x́)	(x x́)	
		mitʃʊ́-w	's/he is eating'
		karɔ́t	'carrot'

For three-syllable words, Rosen (2007: 233) proposes the structures in (12):

(12)

Cree	French	Michif	
Wd	Wd	Wd	
/	⋀	⋀	
F	F F	F F	
|	| ⋀	| ⋀	
s	s w s	s w s	
(x́) <(x x̀)>	(x̀)(x x́)	(x̀)<(x x́)>	
		mìtʃʊ́-w-ák	'they are eating'
		ʃɔ̀kɔlá	'brown'

Recall that the final foot is ignored in Cree and Michif for the purposes of primary stress assignment, but can take secondary stress, as discussed above. The constraint in Michif against assigning primary stress to a non-branching foot prevents primary stress from falling on the first syllable in this structure, Rosen argues, and thus it must fall on the final syllable, parallel to French.

Cree, without the branching condition, allows antepenultimate primary stress in this structure.

Finally consider four-syllable words, with the structure in (13) (Rosen 2007: 233). (I follow Rosen 2007: 233 in the placement of secondary stress in French; she notes (p. 229) that this stress is optional.)

(13)	Cree	French	Michif	
	Wd	Wd	Wd	
	/	⋀	/	
	F_s	F_w F_s	F_s	
	⋀	⋀ ⋀	⋀	
	w s w s	w s w s	w s w s	
	(x x̀) <(x x̀)>	(x x̀)(x x́)	(x x́) <(x x̀)>	
			nɪ-mítʃʊ-n-àn	'we're eating'
			kɪ-lì-fo-íwɪ-n-àn	'we're crazy'
			kɔmbínɛzɔ̀	'longjohns'

Primary stress falls on the antepenult in both Cree and Michif, while French has final primary stress.

Rosen (2007: 233) points out that "Michif could be thought of as an amalgam of the two source languages. In words of three syllables, the parameters yield the same stress pattern as French, and in words of more than three syllables, they are the same as Cree. Michif has not simply adopted one of the source language's stress systems, but rather innovated a mix of the two."

Rosen goes on to discuss why the Michif stress system might have developed in this way. She speculates that the development of the stress system in Michif is similar to that of English. Rosen cites Dresher and Lahiri (2005), who argue that Latin loanwords were able to change the parameters of English stress because they were generally longer than English words. Words of the native pattern did not change, but the system changed because of the new longer words. Rosen says: "This may also have been the case with Michif, where French would have introduced many more shorter words into the Plains Cree system, which in turn changed the parameters of the stress system. Speculating, this seems especially plausible seeing as though the Michif and Plains Cree stress systems are so similar other than for shorter words: the part of the Michif lexicon on which French would exert the most influence" (Rosen 2007: 235).

A brief aside on word length is in order. In Michif, the effect of French is visible in three-syllable words; as above, Rosen suggests that the introduction of shorter words through French might have led to the reconfiguring of the stress system. Word length is also involved in Stoney, discussed in section 6.3.1: with longer words, the effect of the English system becomes visible. It is not clear if English introduced more long words into Stoney, but it is perhaps possible that length played a role in the development of the Stoney stress system.

The analysis of Michif is coherent without an appeal to French, as van der Hulst (p.c. 2012) points out. However, it is interesting that Michif did not simply maintain the Cree stress pattern, but accommodated French to the degree it could.

6.3.3 Cree-Montagnais-Naskapi

Cree-Montagnais-Naskapi (Central Algonquian) perhaps presents a similar example of borrowing of a prominence pattern. In most of the Central Algonquian languages, stress is reported to be iambic, with feet constructed from the right edge of the word (see Milligan 2005 for a summary). Dyck *et al.* (2006) describe Northern East Cree, part of this dialect continuum, as having iambic feet, built from the right edge of the word, excluding the final syllable: stress falls on a penultimate heavy (long vowel or diphthong) syllable, on an antepenultimate heavy syllable if the penultimate syllable is light, and on the penultimate syllable if both pre-final syllables are light, although they also report considerable variation and some morphological conditioning. MacKenzie (1980) remarks that there are some Cree-Montagnais-Naskapi dialects where stress falls on the final vowel of the word. Noting that the dialects with final stress are in contact with French, MacKenzie states that this placement of stress is specifically attributable to contact with French.

It is interesting that these dialects also lost final lax vowels. The development of word-final stress resulting from the loss of final lax vowels would be a natural change in a number of cases – when a pre-final CVCV or CVCV: was followed by a final syllable with a lax vowel, final stress would result. Thus, it is not clear how much contact with French played a role in this shift, or whether this is a natural change – vowel loss – which created a stress system that resembles that of French.

6.3.4 Summary

Whether the stress shift in the Cree-Montagnais-Naskapi dialects can be attributed to contact or not, the case of Stoney seems clear, and Michif combines properties of Cree and French in its stress system. In Stoney, in addition to its inherited second syllable stress, a stress system also occurs that is sensitive to weight at the right edge. This language might be classified as a mixed prominence system, with characteristics of both languages. Michif combines properties of two similar stress systems, although in this case the system that is created is mixed in terms of its origins, but is coherent in and of itself.

With loanwords, prominence patterns of the source language can be maintained in the recipient language, or they can be replaced with a recipient language pattern. Moving beyond words to patterns, Stoney shows that a source

language pattern can be added to a recipient language pattern; Michif illustrates that similar source and recipient language patterns may meld to create a new pattern, maintaining aspects of the patterns of both of the languages. These examples suggest that contact can result in the borrowing of an abstract pattern, resulting in language change.

6.4 Shared accent systems within the native languages?

I now turn to the languages indigenous to the Americas in order to investigate if prominence systems have been subject to borrowing, as in Stoney, or convergence, as in Michif. This turns out to be a challenging task, for more than one reason.

6.4.1 Introduction

In order to understand whether borrowing of a prominence system has occurred, it is important to begin with an understanding of what we must look for, and what we might expect to find, given the complexities of these systems. I start with the latter.

There are many types of similarity that might be found between languages in contact that could possibly be attributable to borrowing resulting from contact. For one thing, it is possible that prominence is implemented in a common way in languages in a linguistic area; for instance, prominence, whatever its position, might be implemented as tone. Patterns might also be similar. For example, edge orientation from which primary prominence is determined might be shared; languages of an area might exhibit rhythm systems; languages might exhibit Quantity Sensitivity; they might show morphological conditioning for prominence rather than purely phonological conditioning. In addition, it is possible that languages might show similarities at a level higher than the word, i.e. similarities in intonation; see Gordon (this volume) for discussion of how word-level stress and higher-level prominence might be differentiated, and Hyman (this volume) for discussion of various issues involving stress, including the level at which it is relevant; see also de Lacy (this volume) for discussion of some of the challenges of studying stress.

Turning to the first question above – what we might look for to determine if similarities are attributable to contact-induced change – it is important to keep several points in mind. First, in order to establish that similar patterns in languages in contact are best attributable to contact, it is necessary to find evidence of change from one system to another, leading to more similar systems. If the languages in question have the same starting point, contact might reinforce a failure to change, but it is not the factor that *creates* the similarities. As

Conathan (2004: 90–1) points out, contact-induced change results in similarities that are not attributable to chance or to common inheritance. Thus, similarities in and of themselves do not necessarily lead to the conclusion that those similarities arose due to contact. Second, contact does not necessarily lead to identity of source and borrowing systems, as the Michif case discussed in section 6.3.3 demonstrates: Michif has characteristics of both Cree and French, but is not identical to either language in terms of its prominence system; similarly Stoney shares properties of Dakota and English. Third, it is well known that the type of contact situation can have a large effect on the nature of borrowing (e.g. Thomason and Kaufman 1988), so it is critical to understand this as well, although I do not address this important issue here. Fourth, information about prominence in many languages of North America is relatively sparse. In many cases, by the time that discussion of prosodic properties was examined, the languages had very few speakers, and those speakers did not use the language regularly. Finally, it is not always clear how an author uses terms such as 'stress' and 'accent', and whether the terms as used by different authors are comparable with one another. It is important to keep these points in mind in reading the rest of this chapter.

6.4.2 Linguistic areas within North America

A number of linguistic areas have been identified in North America, as summarized in Campbell (1997) and Mithun (1999). Linguistic areas are determined on the basis of shared characteristics that can be phonological, morphological, or syntactic in nature. For instance, size and shape of the consonant and vowel inventories and the presence of tone are phonological characteristics that are often discussed with respect to linguistic areas; morphological characteristics might include word complexity, the presence of case, and the presence of certain types of affix; grammatical patterns include alignment systems.

In this section I survey the prosodic systems of several of the linguistic areas that have been proposed in North America. I address two questions. First, are there aspects of prominence that are shared in linguistic areas? Is this a type of phonological characteristic that we are likely to find common in language areas? The literature cited in the introduction to this chapter, Thomason and Kaufman (1988) and Matras (2009), suggests that prominence can be changed due to contact, with Matras (2009: 231) suggesting that stress is more likely to shift than segmental phonology. And second, if prominence systems are indeed likely to be shared, is there evidence that the sharing is a consequence of contact-induced change? In this survey I summarize overall patterns without detailed data for the most part; see Rice (2010) as well as the sources for data.

6.4.2.1 Northern California

One of the better-described linguistic areas is Northern California; see, for instance, Campbell (1997), Mithun (1999, 2010), Conathan (2004), Jany (2009), and Golla (2011) for recent work and references. This group includes the Algic languages Yurok and Wiyot, the Athabaskan languages Hupa, Mattole, and Kato, the Yukian language Yuki, the isolate Wappo, the Miwokan languages Lake Miwok and Southern Sierra Miwok, the Wintuan language Wintu, the Maiduan language Maidu, the Plateau Penutian language Klamath-Modoc, the Pomoan languages, the isolate Chimariko, the Palaihnihan languages of Achumawi and Atsugewi, the isolate Karuk, the Shastan language Shasta, and the isolate Yana.

One of the phonological features used to identify this area as a linguistic area comes from the nature of the consonant inventories. The consonant inventories tend to include voiceless unaspirated stops and affricates and ejectives, and some of the languages have ejective fricatives as well. This inventory type can be seen in the two languages shown in (14), Chimariko (isolate) and Hupa (Athabaskan) (from Mithun 2010: 675). Other Athabaskan languages also have relatively large consonant inventories; thus Hupa is representative of this family.

(14) a. Chimariko
p t ʈ ts tʃ k q p’ t’ ʈ’ ts’ tʃ’ k’ q’ ʔ p^h t^h $ʈ^h$ ts^h $tʃ^h$ k^h q^h s ʃ x χ h m n l r y w

b. Hupa
b d ts tʃ k^y g q t^h ts^h $tʃ^h$ $tʃ^{hw}$ k^{hy} k^h t’ ts’ tʃ’ tɬ’ k^{y}’ k’ q’ s ɬ ʃ x^w x m n ŋ l w w̥ ’n ’ŋ ’l ʔ h

Other languages in Northern California also have large consonant inventories. The two Northern California languages Yurok and Wiyot are sometimes classified together as Ritwan, and are related to Algonquian languages, with these two groups forming a family known as Algic. The inventories of Yurok and Wiyot are given in (15), cited from Mithun (2010).

(15) Ritwan branch Algic languages
Yurok: p t tʃ k k^w p’ t’ k’ k’^{w} s ɬ ʃ x m n l r w y ɣ ‘w ‘l ‘r ‘ɣ ʔ h
Wiyot: p t ts tʃ k k^w p^h t^h ts^h $tʃ^h$ k^h k^{hw} s ɬ ʃ h b d g l r m n w y

Proto-Algonquian, on the other hand, is argued to have a far simpler inventory, lacking the laryngeal contrasts found in the California languages, as in (16), from Mithun (2010: 675).

(16) Proto-Algonquian p t tʃ s ʃ h m n θ l w y

Mithun (2010: 675) notes: “There is clear consensus that there are no genetic links among the Algic languages and their Chimariko and Athabaskan neighbors. Northern California is known as an area of longstanding multilingualism.

Communities have always been small and intermarriage has been the norm. The consonant inventories reflect this history."

Is this similarity of inventories between the languages of Northern California due to contact-induced change, such that the Algic languages expanded their inventories through contact with other languages with larger consonant inventories? Proulx (1984) reconstructs a large inventory of consonants for Proto-Algic, with labials, three coronals, velars, and labiovelars, and voiceless unaspirated, glottalized, and aspirated consonants in the stops, and both plain and ejective voiceless fricatives and sonorants. In this case then, assuming his reconstruction is more or less correct, by Proto-Algonquian the consonant inventory would have diminished in size. This suggests that contact-induced change may well not be what is important here; instead, contact with languages with large consonant inventories perhaps functioned to maintain the larger size, keeping the languages similar in terms of size and shape of the consonant inventory but not *creating* the similarity that exists.

In the following discussion I ask whether prominence in North California is something that might have been subject to contact-induced change, or if, as Conathan notes for other features, diversity might still be maintained despite the intensive contact. The core question is the following: Do bilinguals seek to reconcile prominence systems? The literature cited in the introduction (e.g. Matras 2009) suggests that prosody may well be a feature that will commonly be shared. Conathan (2004) argues for functional convergence in the languages of Northern California, looking at a number of morphological and syntactic criteria. She concludes that there has not been so much borrowing or shift-induced interference, but rather functional convergence, with similarity in the semantic and pragmatic categories, but not increasing similarity in surface syntax.

What would this mean with respect to prominence? It is not hard to imagine with respect to intonation, where the notion of function is quite clear, but what about with respect to word-level stress? Is this an area where we might find borrowing or shift-induced interference?

Jany (2009), in a study of Chimariko, provides extensive comparison of this language, an isolate, with neighbouring languages of Northern California: Hupa (Athabaskan), Shasta (Shastan), and Wintu (Wintuan). Jany notes that "Stress systems show many similarities in the languages of Northern California. Immediate neighbors of Chimariko: Hupa, Shasta, and Wintu, all show weight-sensitive stress systems. While their weight hierarchies are slightly different, all have CVV as their heaviest syllable. Root stress, as well as penultimate stress and leftward attraction of stress, are also very common in the area. Shasta, for example, has penultimate stress, but moves the stress in longer sequences to the first preceding heavy syllable. Acoustic correlates of stress include pitch and intensity for Hupa. For Shasta, a high-low pitch tonal accent

has been described. Hence the acoustic correlate of stress in Chimariko, which is pitch, is also attested in other languages of the area. *Given that stress is easily transferred through language contact* [my italics], it is likely that the languages in Northern California have shifted their stress patterns as a result of multilingualism in the area" (Jany 2009: 32).

Jany (2009) examines Northern California through the lens of Chimariko, looking at shared patterns with closer and more distant neighbors, and I will follow her in examining what is known about prominence in these particular languages.

This set of languages presents a number of challenging issues in determining if shared characteristics are attributable to contact for several reasons. First, some of the languages are isolates or come from very small families that were little described. Thus, it is difficult to determine if patterns of prominence have shifted, as it is not clear what the patterns might have been historically. In addition, much of the work on these languages was done after long-term contact, not only with indigenous languages but also with European languages. There is no record of whether systems underwent a shift in patterns, and the paucity of data on related languages does not allow for comparative reconstruction. Third, as noted earlier, available data is often drawn from a small number of speakers, sometimes only a single speaker, and often speakers who were not regular users of the languages involved at the time that the work was done. Fourth, the documentation is often poor. Golla (2011: 209) notes that "Accentual uses of pitch and tonal phenomena occur widely in the languages of the northern part of the California region, but in most instances the documentation is poor". Fifth, again repeated from earlier discussion, it is not clear if the terms such as 'stress' and 'accent' are used in a systematic way across the literature on these languages. Finally, it is often the case that actual forms showing the stress pattern are not given in the literature, but that the pattern is simply described.

Despite these issues, given Jany's observation about stress noted above, it is worthwhile to pursue what these languages might have in common.

Jany (2009) identifies the following neighbors of Chimariko, dividing them by distance from Chimariko.

(17) Closest neighbors: Wintu, Hupa, Shasta
Distant neighbors to the (north)west: Karuk, Yurok, Wiyot
Distant neighbors to the east: Yana, Achumawi, Maidu

In the following discussion, I summarize and compare the prominence systems of these languages. I focus on the edge from which primary stress is determined (referring to this as 'edge orientation'), Quantity Sensitivity, rhythm, and the phonetic implementation of prosodic features when this information is available. When I use the term 'prominence', I refer solely to what is called

'primary stress' by many of the authors. In addition I include comments on morphology when appropriate, as many of these languages are morphologically complex, and prominence is sometimes morphologically conditioned, a feature that could be important. I do not attempt to classify languages in terms of system type (e.g. iambic, trochaic), nor in terms of features such as extra-prosodicity – these are analytic issues, and different analysts do not necessarily provide the same analysis. Because data with stress marked is often not included in the descriptions, I summarize the stress systems simply by focusing on the orientation of prominence, Quantity Sensitivity, and realization as described in the literature, with data included only occasionally.

The Chimariko stress system is described in detail by Jany (2009). As summarized in (18), stress is attracted to roots; these are generally disyllabic (p. 23), with stress falling on the penultimate syllable of the root, and long vowels in roots are stressed even if they are not in this position (pp. 27–8). The language is largely suffixing, with personal pronouns and possessors either prefixed or suffixed (p. 13). Thus prominence is realized near the left edge of the word, on one of the first three syllables. Prominence is realized as high pitch, and, in addition, word-final vowels lengthen, especially in open syllables (p. 28).

(18) Chimariko

a.	ˈapu	'fire'
	muˈtakweh	'rain'
	x-uˈkee-na-tinda	'you don't understand'
	NEG-understand-NEG-ASP	
b.	orientation	left edge
	Quantity Sensitivity	yes, to vowel length
	realization	pitch

Turning to one of Chimariko's close neighbours, Wintu, there is some variation among speakers as to where prominence falls. Pitkin (1984) notes that stress is morphologically conditioned, falling on the first heavy syllable of the stem, with first syllable default. Primary stress is left-edge oriented, with secondary stresses on alternating syllables following primary stress. Wintu has prefixes; these too take stress, realized in the speech of the speakers who worked with Pitkin as secondary stress. The stress system is coherent, with prefixes also taking stress on the first heavy syllable, and first syllable default. Pitkin notes that stress is realized as tenseness, loudness, and higher pitch. Schlichter (1981), working with different speakers, notes that one of the speakers had a different stress system, with stress only on the first syllable, without Quantity Sensitivity. The system is summarized in (19b), with (a) representing the analysis presented by Pitkin and (b) the analysis for one of the speakers who Schlichter worked with.

(19) Wintu

a.	ˈbe:le:s	‘it could be’ (Pitkin 1984: 20)
	c’iˈyi:ya	‘to be all squashed up’ (Pitkin 1984: 19)
	ˈwerleˌbo:sken	‘you will all have to come’ (Pitkin 1984: 20)
	puˌba:n-ˈp’urun	‘of those others’ (Pitkin 1984: 22)
b.	orientation	a. left edge
		b. first syllable
	Quantity Sensitivity	a. yes, to VV
		b. no
	secondary stress	a. on following heavy syllables
		b. none
	realization	tenseness, loudness, pitch

Prominence in Hupa (Athabaskan) has received different descriptions. Sapir marks something in the Hupa texts recorded in 1927 (Golla and O’Neill 2001) that is interpreted by Gordon and Luna (2004) as stress. Gordon and Luna (2004), in a study of these texts, conclude that Hupa had a weight system, with a two-syllable window at the left edge of the word, making stress left-oriented, with little attention to morphological structure. A summary of the Hupa system at Sapir’s time is given in (20). Note that there are also cases of stress further to the right.

(20) Hupa 1 (Sapir; data taken from Gordon and Luna 2004)

a.	initial	ˈxontah	‘house’
	peninitial	xoˈta:jaʔkʲeʔeʔil	‘they swim down the river’
	after second syllable	ʌiq’oʔohˈtine:	‘help me (ye)!’
b.	weight hierarchy	CVV > CVC > CV > CVH, two-syllable window at left edge, left default if syllables equivalent in weight	
	orientation	left edge	
	Quantity Sensitivity	yes	

Gordon and Luna (2004) carried out an acoustic study of stress in Hupa, and find a slightly different system. They report a similar hierarchy, with the leftmost long vowel being stressed. In the absence of long vowels, stress generally falls on the root, generally the rightmost element of the word.

(21) Hupa 2 (more recent; data from Gordon and Luna 2004)

a.	long vowel	ˈna:tł’aʔ	‘backwards’
	vowel-glide	mɪq’oˈstaw	‘nine’
	leftmost long vowel	ˈno:k’mje:jo:t	‘dog’

b.	weight hierarchy	CVV > CVC > CV > CVH, leftmost CVV syllable; on root in the absence of prefix long vowels
	orientation	left-edge; right edge (stem) default
	Quantity Sensitivity	yes
	realization	intensity, pitch

Golla (1970: 40–1), in writing on prominence in Hupa, reports that the language has a Quantity-Sensitive stress system, with the long vowel of a closed syllable the most highly stressed, followed by a long vowel in an open syllable. Golla further notes an overall drop in pitch over the course of a sentence.

Gordon and Luna (2004) comment on the different systems in Hupa, questioning whether the differences are due to the different nature of the data or to language change over time.

Shasta was studied by Silver (1966) at a time when the language was moribund, and while other Shastan languages are identified, they received very little description. Silver provides a detailed description of prominence in Shasta. There are two contrastive tones, high and low. With respect to stress, Silver describes the system as follows.

(22) Shasta (Silver 1966)

Location	penultimate syllable in a sequence of three or more of the same syllable type; if the penultimate is light and there is a preceding heavy, stress the heavy
Quantity Sensitivity	yes

In terms of morphology, nouns may take suffixes; in the verb system, prefixes mark a mode–tense–person–number combination, and there are optional suffixes. In general, then, stress in Shasta is determined from the right edge, and is Quantity Sensitive.

Of the languages that Jany (2009) classifies as Chimariko's closest neighbors, Chimariko, Wintu, and Hupa have left-oriented prominence; Hupa has prominence on the stem in the absence of quantity, at the right edge of the word, and Shasta has right-oriented prominence. As Jany points out, these languages have all been analyzed as Quantity Sensitive.

While the patterns are areal, it is difficult to determine whether these patterns are attributable to contact-induced change, given that, other than Hupa, the languages are isolates or from families either with little internal variation or where languages are little described. While there are no extensive studies of non-tonal prominence in Athabaskan languages, Hargus (2005: 416) notes that there are several factors that are important in the determination of the position of stress in two languages of British Columbia, Sekani and Witsuwit'en. Morphological

properties (stem vs. affix) and phonological factors (quantity) are both important, as is position within the word (initial vs. medial). Kari (1990: 17) remarks that stress is predictable in Ahtna, an Athabaskan language of Alaska, with primary stress on the rightmost stem syllable, and long vowels also receiving primary stress. Tanana, also spoken in Alaska, has stress on stems as well as on heavy syllables (Tuttle 1998). In Tahltan, primary stress is on the stem unless there is a prefix with a long vowel (Alderete and Bob 2005). Another language of Alaska, Dena'ina, has the following pattern: the stem is generally stressed, with stress shifting to the left of the stem onto a full vowel; with two or more long vowels before the stem, either the pre-stem syllable is stressed or both long-vowel syllables are stressed (Kari 2007: xxvii). Moving closer to Hupa, Mattole, another Californian Athabaskan language, is described by Li (1930: 50) as not being strongly accented, with a tendency to accent the stem syllable (usually at the right edge) or the syllable preceding the stem.

Without more work on the reconstruction of stress in the Athabaskan family it is not clear what to make of the Hupa system. Leer (2005) argues that stress is morphologically determined, being attracted to the stem in the family, but further factors have not been systematically investigated. It is possible, given that Mattole does not appear to show Quantity Sensitivity, that Hupa Quantity Sensitivity is indeed a consequence of contact-induced change. Alternatively, it could be that Mattole lost its Quantity Sensitivity, with the areal characteristic functioning to deter Hupa from losing it.

I turn now to the Chimariko neighbors that Jany classifies as distant: Karuk, Yurok, Wiyot, Yana, Achumawi, and Maidu. Again, the view that I present is adapted from Jany (2009), and is Chimariko-centric; a systematic study would compare each of the languages with its own closer and more distant neighbors, both geographically and in terms of contact.

Karuk is an isolate. Bright (1957: 13) describes the prosodic system as follows. There is strong stress on long vowels, with stress on the final syllable if there are no long vowels (e.g. kukˈʔu:mi 'go there', ʔiʃˈpuk 'dentalium shells'). It is not clear where stress falls if more than one long vowel is present. Prominence is realized as pitch, with high pitch on an initial long pretonic vowel and strong stressed syllables showing falling pitch.

Yurok (Algic) stress has been studied recently by Blevins (2003), with a focus on stress in nouns. Blevins describes this stress system as follows. Stressed syllables are louder and longer than unstressed syllables, and may bear high pitch; unstressed syllables are reduced. Long vowels are always stressed, with high pitch, which may spread rightward to stressed syllables. Closed syllables with short vowels may bear stress when non-adjacent to long vowels but are not always stressed in final position following a closed syllable. Light syllables can be stressed only in the absence of long vowels and non-final closed syllables; the position does not appear to be consistent (e.g. ˈhe.yo.mus 'skunk',

ˌci.no.ˈme.wes ‘adolescent boy’; Blevins 2003: 21). Stress is realized as intensity, lengthening, and high pitch.

Wiyot (Algic) is described as having a lexical stress system (Proulx 1984: 195), where a historical long stem vowel is stressed if there is one; in the absence of a long vowel, the first vowel of the stem is stressed (Proulx 1984; Reichard 1925; Teeter 1964), making the system left-oriented with respect of the stem (e.g. bəˈlid [*meli:ni] ‘eye’; ˈwakəl [*wa:kel] ‘peppernuts’; from Proulx 1984). There are possessive prefixes, inflectional suffixes, and preverbs.

In Yana, another isolate, described by Sapir and Swadesh (1960), prominence falls on the first heavy syllable; in the absence of heavy syllables, the first syllable is stressed (e.g. iˈta:lʔpa ‘head scratcher’, ˈgalu ‘arm’).

Achumawi (Palaihnihan; Mithun 1999) has two tones, high and low; no stress is reported. Olmsted (1966) reports four tones.

Maidu (Maiduan; Shipley 1964) has stress on the first or second syllable – it falls on the first syllable if the syllable was historically heavy, and otherwise it falls on the second (e.g. ˈjukbom ‘bear dance’, wiˈsetpem ‘frightened’). Primary stress is realized as pitch, loudness, and tenseness. In the related languages (Konkow, Nisenan), stress is initial.

To summarize, I have reviewed the prominence systems in several languages of the Northern California linguistic area, drawing on the literature on the languages for the description. There are clearly shared characteristics among these languages, as well as some different ones; a summary is provided in the table in (23). Note that in some languages prominence is realized tonally, while others are reported to have both a tone and a stress system; I do not differentiate these in the table. I leave ‘edge’ blank when the system appears to have prominence attracted to quantity and it is not clear what the default position is (i.e. when there are only non-heavy syllables in the word). The parentheses around Quantity Sensitivity (QS) signal that the position of prominence is sensitive to historical Quantity Sensitivity, with merging of long and short vowels.

(23) Northern California: summary

	Chimariko	Wintu	Hupa	Shasta	Karuk	Yurok	Wiyot	Yana	Maidu
QS	√	√	√	√	√	√	(√)	√	(√)
edge	left	left	left	right	long vowels; default to right		left	left	left
tone	√			√	√				√

Quantity Sensitivity and left-edge orientation can be added to the list of areal traits in Northern California, as Jany (2009) proposes. Is contact a source of these similarities? It is difficult to ascertain this, given that many of the languages are isolates: we do not have sufficient information about related

languages, in cases where the languages are not isolates, to know what the historical situation is likely to have been. The resemblances summarized in (23) are intriguing, but it is not clear how to evaluate them in terms of the function of contact.

Given that both Quantity Sensitivity and left orientation are found in systems throughout the world (see, for instance, Goedemans 2010 and Goedemans and van der Hulst 2011), more information is needed to determine what might be due to contact. One way to examine this would be to look at other languages in the geographical area that are not considered to be part of the linguistic area. I thus consider a few of the languages that are in the geographical area but not discussed by Jany. These include the Pomoan languages, the Miwokan languages, and Klamath. These languages are part of the larger Northern California area identified at the beginning of this section.

Languages in the Pomoan family show some differences in their prominence systems (see section 6.4.2.2), with prominence near the left edge of the word. Miwokan languages have prominence near the left edge of the word as well, with Quantity Sensitivity. Klamath (Plateau Penutian) stresses the rightmost long vowel, with penultimate or antepenultimate stress in the absence of long vowels (Barker 1964). Thus, while not part of the Northern California group considered by Jany, but part of the larger area, these languages suggest that left-oriented prominence is common in languages of the geographical area both within families and between families.

Many of the languages in the Northern California group show left-oriented stress with Quantity Sensitivity, clearly making these characteristics an areal trait. Whether this is due to contact effects is less clear, however, as the kind of evidence that would show that there was change that can be attributed to contact is not available.

6.4.2.2 Clear Lake (California)

Clear Lake is a small area within Northern California that includes members of the Utian (Miwok-Costanoan), Wintun, and Pomoan families as well as the isolate Wappo. More specifically, Campbell (1997) includes Lake Miwok, Patwin (Wintun), Southeastern Pomo, Eastern Pomo, and Wappo in this group. Given that there are two language families here with several languages (Utian, Pomoan), this might be a reasonable area to look for contact effects.

Mithun (1999: 317) cites phonological evidence for this group. Lake Miwok has plain, aspirated, ejective, and voiced stops as well as affricates and liquids that are not present in the other Miwok languages but are in other languages of the Clear Lake area; Callaghan (1964, 1987) shows that many of the words containing these sounds are from surrounding languages including Pomo, Patwin (Wintun), and Wappo.

What about prominence? The Miwok languages generally have stress on one of the first two syllables, with sensitivity to quantity. Lake Miwok (Callaghan

1965) shows stress on the second syllable if it is heavy, and otherwise on the first syllable; it is realized as high pitch and emphasis (Callaghan 1964: 40). Other Miwok languages often have stress on the first syllable if it is closed and on the second syllable otherwise (Callaghan 1987; Freeland and Broadbent 1960; Broadbent 1964). The languages are primarily suffixing, and thus stress is near the left edge of the word. Mutsun (Utian; Okrand 1977), related to the Miwok languages, had first syllable stress.

The Pomoan languages vary in their prominence patterns. In Eastern Pomo (McLendon 1973, 1975, 1996), one of the languages in the Clear Lake areal group, primary stress, realized as loudness, is on the first syllable of the root; there is frequently a prefix preceding the root, and thus stress is often on the second syllable. McLendon (1973: 33) notes that in Southeastern Pomo, also in the Clear Lake areal group, stress is on the first syllable. Stress is penultimate, probably at the clause level, in Southern Pomo, while Northern Pomo, Central Pomo, and Northeastern Pomo are similar to Eastern Pomo in having stress on the root, with it usually appearing on the first or second syllable of the word (McLendon 1973). In Kashaya, stress is sensitive to quantity, being determined from the left edge, although left-edge light syllables do not enter into the computation of stress (Buckley 1994). McLendon (1973: 34) proposes that pitch-stress accent was phonemic in Proto Pomo, although probably morphologically predictable, occurring on the root, at or near the left edge.

Wappo, another language in this area, is not well described in terms of prominence. Thompson *et al.* (2006) note that stress falls on the first syllable of the stem; there are both prefixes and suffixes. It appears that stress is generally near the left edge. There is some debate as to whether Wappo is an isolate or Yukian (see Mithun 1999: 554); it has a similar stress pattern to Yuki. Like Wappo, Yuki has stress on the first syllable of the stem. The language is largely suffixing, so that prominence, realized as high pitch, appears at the left edge (Sawyer and Schlichter 1984; Mithun 1999); secondary stress is also present, realized as a lower pitch.

Looking at this group of languages, primary prominence is generally near the left edge, sometimes with morphological conditioning. This is the pattern within the Miwok languages generally. Within the Pomoan languages, there is a left-orientation for the determination of stress, although details differ. This is summarized in the table in (24).

(24) Clear Lake area: summary

	Lake Miwok	Wintu	Southeastern Pomo	East Pomo	Wappo
QS	√	√			
edge	left	left	left	left	left

There is no question that the Clear Lake area is characterized by left-edge prominence systems. A reasonably close language that is not part of this group, Yokuts (Yokutsan; Newman 1944), has a different pattern, penultimate prominence. It is tempting to claim that the left-oriented pattern is a consequence of contact. However, given the general left-edge orientation of prominence systems in the Miwokan languages and the Pomoan languages, it is difficult to know if there have been changes in systems to yield this similarity or if the similarity is a result of genetic relatedness and accident, perhaps being reinforced by the contact situation.

6.4.2.3 South Coast Range (California)

Hinton (1991) proposes a linguistic area that she calls the South Coast Range, in California, arguing that California Yuman languages and the Takic branch of Uto-Aztecan share similarities that are not present in other languages of the area, including Chumashan, Salinan, and Esselen. The landscape is complex, and I look at only a few of the languages here.

The Chumashan languages usually exhibit penultimate stress (Mithun 1999).

Esselen had penultimate stress (Shaul 1995). This system is determined based on written records.

Of the other languages that Hinton includes, there is material available on the Yuman languages Diegueño and Quechan and on the Uto-Aztecan languages Chemehuevi, Cahuilla, Cupeño, and Luiseño.

The two Yuman languages, Diegueño and Quechan, both have prominence on the final syllable of the stem; the languages have both prefixes and suffixes (Langdon 1975). There are more prefix positions than suffix positions in these languages, making stress generally near the right edge of the word.

The Uto-Aztecan languages are more varied in terms of stress placement. Cahuilla exhibits prominence on the first syllable of the root, and the system is Quantity Sensitive (Seiler 1965). The language has some prefixes, but stress is generally at the left edge. Luiseño (Munro 1990), in the same subgroup as Cahuilla, generally has stress on one of the first two syllables of the root, attracted to long vowels, with stress on the first syllable in verbs and the second syllable in nouns in the absence of long vowels. Cupeño, also in the same subgroup as Cahuilla, usually has stress on one of the first two syllables, occurring on historically long vowels (Munro 1990). Chemehuevi, in a different Uto-Aztecan subgroup, exhibits second-syllable prominence (Press 1979). These languages thus have left-oriented systems.

Finally, Yokuts (Yokutsan; Newman 1944) is also identified as part of this area; it generally has penultimate stress.

The overall patterns in the languages discussed in this section are summarized in (25).

(25) South Coast Range area: summary

	Chumash	Esselen	Yuman languages	Cahuilla	Luiseño	Cupeño	Chemehuevi	Yokuts
Edge	right	right	right	left	left	left	left	right
QS				√	(√)	(√)		

What can we conclude about prominence in this group? It is right-oriented in Chumashan, Esselen, the Yuman languages, and Yokuts, while in the Uto-Aztecan languages of the group it is left oriented. Hinton 1991 notes that the Takic Uto-Aztecan languages (Cahuilla, Cupeño, Luiseño) exhibit many Yuman area traits, suggesting long-term contact with Yuman languages. However, there does not appear to have been an effect on the prominence system: while most of the languages of the area exhibit right-oriented stress, this is not the case with these Uto-Aztecan languages.

Turning to other languages in the geographical area, the Uto-Aztecan languages Kawaiisu and Tübatülabal exhibit right-oriented stress, while Southern Paiute and Western Shoshone have left-oriented prominence; all are Quantity Sensitive. The Uto-Aztecan family is not uniform in its prominence patterns, but the languages in closest contact with the Yuman languages do not, as noted above, show Yuman prominence characteristics in terms of orientation, in any case.

6.4.2.4 Plateau (Plateau Penutian: Klamath, Sahaptian, Molala)

The final linguistic area that I consider is Plateau. The Plateau linguistic area includes Plateau Penutian languages, including two Sahaptian languages, Nez Perce and Sahaptin, Klamath, and Molala, the Chinookan language Upper Chinook (also known as Kiksht), the Athabaskan language Nicola (Athabaskan), the Interior Salish languages (Salishan), and some isolates, Cayuse and Kootenai.

Nez Perce (Crook 1999) has lexical accent, with predictable stress on the penultimate syllable that is obscured when the word has lexical accent. Hargus and Beavert (2001, 2002, 2006) analyse Yakima Sahaptin as having lexical accent, with stress on the heavier of the first or second syllable, with default to the first. Klamath is analyzed by Barker (1964) as having Quantity-Sensitive stress, determined from the right edge, with pitch related to stress. Kootenai (Garvin 1948) has penultimate stress, with exceptional final stress. Interior Salish languages generally exhibit prominence as far to the right as possible, subject to some morphological constraints, with a few of the languages exhibiting a different system. Czaykowska-Higgins and Kinkade (1998) say that Lillooet, a Central Salish language, has penultimate or final stress, with weight restrictions and some morphological characteristics, while Shaw (2009) argues

that stress in Lilloet falls on the leftmost full vowel that is not in a prefix. There is insufficient knowledge of the other languages of this area to comment on their stress systems meaningfully.

The characteristics of these languages are summarized in (26).

(26) Plateau area: summary

	Nez Perce	Yakima Sahaptin	Klamath	Kootenai	Interior Salish (minus Lilloet)
Edge	Right	Left	Right	Right	Right
QS		√	√		√

Several of these languages have prominence that is oriented to the right edge (Nez Perce, Klamath, Kootenai, most Interior Salish). The Salish family bears further investigation: there are different stress patterns in this family, as discussed by Czaykowska-Higgins and Kinkade (1998). While prominence in this family does not tend to fall on prefixes, it varies in the stem-suffix domain. It is possible that the position of stress in Interior Salish is affected by contact; we cannot be sure of this, however, without a good understanding of the development of Salish stress, and Czaykowska-Higgins and Kinkade (1998: 15) note the challenges in doing this, suggesting that stress in Salish has complications similar to those of Indo-European.

Looking beyond languages in the general area that are classified as Plateau Penutian, Central Kalapuyan (Kalapuyan) has final stress (Berman 1990). Two Northern Uto-Aztecan languages show different orientations of primary prominence, with Eastern Shoshone (Miller 1996) having initial stress and Mono having final prominence (Miller 1996). Again, it is difficult to know if the similarities that arise in this area are due to convergence or not, and in some cases the presence of lexical accent, something that is fairly common in the Plateau area, may obscure otherwise predictable patterns.

6.5 Summary

I have examined prominence in four linguistic areas of the Pacific Coast of North America. There are many similarities between the languages in each of these four groups in terms of their prominence systems and how prominence is realized; with respect to the system, I have noted in particular edge orientation and Quantity Sensitivity. Based on this study as well as on the literature on language contact, prominence patterns and realization definitely appear to be topics to address in the study of areal features. However, due to the nature of the linguistic areas under study in this work, the factors that lead to the areal pattern are not readily apparent. It is often difficult to know whether

the similarities are due to contact-induced change (as is likely in Stoney and Michif), are accidental (as is likely in Cree-Naskapi-Montagnais dialects), or are due to genetic inheritance.

I would like to close with some cautions of different types, and some looking ahead to future study. First, in terms of languages, one might ask if the linguistic areas of North America represent a good place to study possible causes and effects of contact. As has been discussed, there are many challenges to this. For one, there are many isolates, and families with only a few languages recorded, so it is often not possible to know whether similarities are due to genealogical history, to contact, or to other factors. Further, as discussed earlier, in many cases the linguistic work was done with only a few speakers, and often not many speakers of the language remained at the time the work was done. In addition, the descriptions are not always clear, transcriptions can be hard to interpret, and it is not always apparent if different researchers are using terms in the same way, so it is not clear if comparisons between languages are based on similar kinds of analyses. For a single language, different analysts sometimes propose different analyses, with the analysis differing depending on the speaker (e.g. Wintu) and over time (e.g. Hupa), or because of different types of data (see Gordon and Luna 2004 on Hupa).

Second, prominence systems are vulnerable to change in general, not just due to contact. For instance, in the Cree-Montagnais-Naskapi dialects discussed in section 6.3.3, loss of a vowel is likely a factor in the creation of a word-final stress system, replacing a Quantity-Sensitive system. In Quantity-Sensitive systems, quantity may be lost, with different languages taking different paths in terms of what remains (see Rice 2010 for some discussion with respect to North American languages). Morphological conditioning may be lost or gained (perhaps what occurred in Hupa). These can be changes that come about internal to the system itself, without any external influence.

What might a full study of change in prominence systems include? First, it is important to understand the kinds of change that can occur within a language through internal change, without contact. Such changes could, of course, be triggered by contact, but a typology of change would highlight cases where contact might be a likely explanation for a kind of change. In-depth studies of the development of prominence systems in the absence of contact would help to understand the types of change that are likely.

One could then study systems in contact. Are the changes introduced by contact part of the typology of change in general, or are there new patterns introduced? For instance, in the case of Stoney, in contact with English, the contact brought systems together where the stress systems could be melded, basically maintaining the integrity of each. It strikes me that this particular change is an unlikely one in the absence of contact, given that the right-edge stress mimics English in terms of the relationship between position and weight.

In Michif and Old English, it appears that contact introduced more long words, allowing for the adaptation of stress patterns that were similar to begin with. These changes too strike me as unlikely in the absence of contact. If this turns out to be the case, then there are patterns of shift that might be identified as most likely attributable to contact.

It is also important to study languages on the same terms. I have looked at orientation, Quantity Sensitivity, and realization at the word level, but there are other possibilities. Systematic data might reveal similarities that are not obvious from the current descriptions. In addition, recordings done under similar conditions would be helpful in looking at the realization of prominence; again, languages might be more similar or more different than we think based on the descriptions.

Is North America a good place to carry out such a study? Despite the contact that clearly existed within North America, both between indigenous languages and between indigenous and European languages, it is not the best venue for such a study. There are many isolates, thus not allowing for an understanding of the starting point; many of the indigenous languages are no longer really spoken and the records are not such that they allow for a careful study of the systems. However, this study highlights some of the many issues that need to be addressed in tackling the issue of contact and prominence systems, and sets out a course of study involving phonetic, phonological, and historical work. North American work can perhaps reveal areal patterns, but it is generally difficult to determine the genesis of those patterns – they may be contact induced, but this is difficult to determine.

To close, I would like to recognize another factor that might be subject to contact-induced change, namely intonation; see Mithun (2008) for discussion. Intonation may well be what Matras (2009) means in referring to the replication of prosody in contact situations, as quoted in section 6.1; see Mithun (2008). Many languages show phrase-initial and phrase-final effects realized as prominence in various ways. Gordon and Luna (2004) speculate that some of the differences between the Hupa stress systems exemplified in Sapir's 1927 texts and in their later work might be due to the different types of material involved, with Sapir's data from narratives and Gordon and Luna's from words spoken in isolation. Intonation would be a particularly interesting area to study for other reasons. Differences in intonation patterns might be particularly salient for listeners to pick out. Mithun (2010) investigates structural parallelisms between languages of Northern California, showing a large number of parallelisms, even in the absence of borrowed words or morphemes. She proposes that the sharing of these abstract patterns could have arisen from the transfer of patterns of expression and frequencies of stylistic choice. One could imagine that intonational patterns could come to be shared through such a mechanism, depending on the types of bilingualism present. Gordon (this volume) offers ideas about

how it might be possible to differentiate word-level stress from higher levels of prominence, and Hyman (this volume) contains interesting discussion of factors involved in stress. While a study of intonation is likely not possible in the context of the language groups under study in this chapter, it may well be an interesting way of pursuing the study of contact-induced change, and sorting out what might be due to contact as opposed to history or accident.

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7 Rhetorical stress in Spanish

José I. Hualde and Marianna Nadeu

7.1 Introduction: on the nature of rhythmic stress

Stress systems with rhythmically alternating secondary stresses have played a major role in the development of metrical stress theory (Halle and Vergnaud 1987).* Hayes (1995: 33), in fact, focuses primarily on such rhythmic systems for his theoretical proposal, stating that "these are the systems that arguably are of the greatest interest from a metrical perspective". It is somewhat perplexing, then, that, in the case of several languages that have been taken to possess such rhythmic secondary stress systems, phonetic investigation has failed to find evidence for them. Thus, Dogil and Williams (1999) did not find phonetic evidence for rhythmic secondary stress in Polish or Spanish, and Arvaniti (1992, 1994) also failed to find evidence for rhythmic stress in Greek. Further experimental work on Spanish secondary stress has also reported lack of acoustic evidence (Prieto and van Santen 1996; Díaz-Campos 2000). Polish, Spanish, and Greek are languages with contrastive primary stress, whose position in individual words is not in question and where, in addition, some phonologists have postulated the presence of rhythmic, alternating secondary stresses on the basis of their intuition. The fact that no empirical evidence has been found so far to support these intuitions raises serious concerns regarding the nature of the evidence that has been used in typological and theoretical work. This can be seen as particularly disturbing because, among those languages that have been claimed to possess rhythmically alternating stress, Spanish, Polish, and Greek have large numbers of speakers and are easily accessible, but, as de Lacy (this volume) points out, for a majority of languages in stress databases we have a single source. If, for languages like Spanish, Polish, and Greek, experimental work has failed to find evidence for rhythmic stress, how much faith can we have in the correctness of the description of the stress systems of less accessible and more poorly documented languages? (de Lacy raises this question also for primary stress in languages where presumably it is not phonologically contrastive.)

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We take the position that an intuition or perception of prominence (like a grammaticality judgment) is a datum to be explained. Data from intuition are worthy of attention to the extent that they are consistent among speakers of the language. When this is the case, we should investigate the source of the intuition. Here we explore the hypothesis that the secondary rhythmic stress patterns that several authors have described for Spanish may have their root in an extrapolation from a phenomenon that we call 'rhetorical stress', which is the optional appearance of readily identifiable stress prominence in certain speech styles on syllables that are not lexically designated to carry stress. This phenomenon has parallels in other European languages such as the 'accent d'insistance' of French (see, e.g. Dahan and Bernard 1996; Féry 2001) and what Arvaniti (1997) calls 'emphatic stress' in Greek. Comparable phenomena are also the stress retraction rules in rhetorical style in Dutch (Gussenhoven 1983) and German (Berg 2008). Unlike the Greek 'emphatic stress', which, according to Arvaniti, is limited in its placement to function words and the initial syllable of content words, Spanish rhetorical stress has a freer distribution and appears to be at least partially related to rhythm, since it is often placed two syllables before the lexically stressed syllable, and not necessarily on the initial syllable.

7.2 Levels and types of stress in Spanish

In Spanish all content words as well as some function words have a lexically stressed syllable. Primary stress contrastively falls on one of the last three syllables of the word (e.g. *lámpara* 'lamp', *mampára* 'screen', *Panamá*; *cántara* 'jug', *cantára* 'I/s/he sang, subjunctive', *cantará* 's/he will sing').[1] Being lexically contrastive, intuitions on the position of the primary stress are crystal clear and the facts are uncontroversial.

In certain compounds, including adverbs in *-mente* '-ly', each member retains its stress, e.g. *pérro-lóbo* 'wolf-dog', *sofá-cáma* 'sofa-bed', *símpleménte* 'simply', *naturálménte* 'naturally'. Whether one of the two lexical stresses is prosodically subordinated to the other is unclear, although the assumption in the literature is that the last stress has greater prominence (see, e.g. Harris 1983).

In addition to this contrastive lexical prominence, some authors have postulated the presence of rhythmically distributed weaker, secondary stresses (Navarro Tomás 1977[1918]: 195–6; Stockwell *et al.* 1956; Harris 1983; Roca

[1] We indicate primary stress with an acute accent and secondary stress with a grave accent. Standard Spanish orthography indicates the position of the primary stress with an acute accent mark when the word does not follow the general pattern. In some cases, the acute accent is thus part of the standard spelling of the word (for instance in *lámpara* and *Panamá*, but not in *mampara*, which follows the general rule that words ending in a vowel are overwhelmingly paroxytonic).

1986; Hyde and McCord 2012). Unlike what is the case with primary stress, the position of secondary stresses cannot be used to establish lexical contrasts, but rather would follow from general rules. The rules of secondary stress assignment are slightly different in the descriptions of the different authors that have postulated the existence of this phenomenon.

For the great Spanish phonetician Navarro Tomás (1977[1918]: 195–6), the (phonetically trained) ear would perceive rhythmic prominence on the initial syllable of the phonetic group and also on alternating syllables counting from the syllable with primary stress (in both directions). The phonetic group includes a morphological word and any unstressed functional words preceding it: *àmistád* 'friendship', *àbadésa* 'abbess', *còntra lò tratádo* 'against the agreement'. (In the examples we adapt Navarro Tomás's numeric schema, which distinguishes three levels of prominence: 3 = primary, 2 = secondary, 1 = no stress.) In cases where these two rules would place stresses on adjacent syllables (or, in Navarro Tomás's statement of the context, "when primary stress falls on the fourth syllable from the beginning", our translation), the stress of the initial syllable prevails over alternating stress: *èmperadór* 'emperor', *pòr la mañána* 'in the morning'. The only case when initial secondary stress is not assigned is when the following syllable carries primary stress, as in *fonéticà* 'phonetics'. It is not difficult to see that Navarro Tomás's system can be understood as resulting from the interaction of three ordered constraints: avoidance of stress clash, initial secondary stress, and alternating stress. In OT terms, the highest-ranking constraint would be avoidance of stress clash, which prevents **èmpèradór*, **fònéticà* from being generated. The ranking of initial stress over alternating stress would decide against **empèradór*, **por là mañána* (asterisks refer to Navarro Tomás's description). The secondary stress system of Spanish would thus show a preference for displaying Edge Prominence (van der Hulst 2012, this volume, chapter 11) over perfect binary rhythm.

Roca's (1986) view of secondary stress in Spanish is similar, but not identical, to Navarro Tomás's rhythmic stress. Roca proposes a basic algorithm that assigns alternate stress counting leftward from the syllable with primary stress, allowing for the optional modification of its output by an initial stress-shift rule. That is, unlike in Navarro Tomás's proposal, Roca's rule generates, for instance, both *empèradór* and *èmperadór*, where the latter pattern is produced by optional initial shift.

Harris (1983: 85–6) also proposes two patterns of secondary stress in Spanish in cases where rhythmic alternation of stresses and initial secondary stress cannot both be satisfied. For him, alternating secondary stresses, as in *gramàticàlidád* 'grammaticality', would produce a more rhetorical flavor, whereas initial secondary stress prevailing over regular alternation, as in *gràmaticàlidád*, would be more colloquial. Like Navarro Tomás (1977[1918]),

Harris (1983) rejects the possibility of secondary stress on a syllable adjacent to the primary, as in **bàndáda* 'flock'. Unlike Navarro Tomás, Harris postulates that secondary stress is assigned at the morphological word level, by the same mechanism that he uses to account for primary stress, but, as Roca (1986) argues, this cannot be correct.

The different descriptions of secondary stress in Spanish that have been given in the literature on this topic are based on the intuition of the researcher or, perhaps, on informal consultation between the researcher and one or more native speakers of Spanish regarding their intuitions of rhythm and prominence. Experimental work has generally failed to find acoustic cues that confirm any of the descriptions above (Scharf *et al.* 1995; Prieto and van Santen 1996; Díaz-Campos 2000).

A phenomenon in Spanish that is beyond dispute, on the other hand, is that, in certain styles, words may occasionally carry clearly perceptible prominence on syllables other than the one with lexical primary stress (Wallis 1951; Bolinger 1962; Quilis 1993; Kimura 2006; Hualde 2007; Belda and de-la-Mota 2010). We will refer to this phenomenon as 'rhetorical stress', as it is a feature of public speech, when the speaker is speaking to an audience. Belda and de-la-Mota (2010) call this phenomenon *sobreacentuación* 'overstressing', and Nadeu and Hualde (2012) refer to it as "emphatic stress', like Quilis (1993), who uses the term *acento enfático o de insistencia* 'emphatic stress or insistence stress'. Rhetorical stress is pervasive in the speech of radio and television announcers, and the public speech of politicians, preachers, and lecturers. In conversational speech, on the other hand, it is not common, although it appears to be part of the personal style of some speakers. In Quilis's (1993: 396) words, stress on a lexically unstressed syllable happens "because of a special emphasis that aims at underlying a specific word or as an affectation of some people" (our translation).

It is likely that the general function of rhetorical stress is to mark the whole discourse (rather than specific words) as important information. In English this effect is obtained by increasing the density of pitch accents on lexically stressed syllables (as reflected in the fact that pitch accent density is much higher in news broadcasts than in colloquial styles). In Spanish, where the overall density of pitch accents is generally higher in conversational style than in English (e.g. Jun 2005: 447; Astruc *et al.* 2013), adding prominence to lexically unstressed syllables serves essentially the same purpose. Nevertheless, the possible functions of rhetorical stress to signal information structure still remain to be investigated.

These rhetorical stresses are easily perceptible when they occur and therefore the description of their patterns of occurrence can go beyond the intuitive level. A question that arises is to what extent their distribution mirrors that of the intuitions of secondary stress that have been reported in the literature. In the

next section we describe an experiment on pattern generalization in rhetorical stress in Spanish that bears on this question. We perform an acoustic analysis in order to provide empirical support for the presence of rhetorical stress. In our view, the reason why previous experimental work on secondary stress in Spanish did not find evidence for it is that the researchers failed to elicit speech that contained rhetorical stresses.

7.3 Experimental study on rhetorical stress

7.3.1 Research question

We test a specific hypothesis regarding the placement of rhetorical secondary stress. Based both on previous description and observation (Hualde 2007, 2009), it was hypothesized that there are two main patterns of rhetorical stress. One pattern, which we label the 'rhythmic stress' pattern, would consist of placing prominence two syllables before the lexically stressed syllable: *pròfesóres* 'professors', *empèradór* 'emperor'. The other hypothesized pattern of rhetorical stress, which we are calling the 'emphatic stress' pattern, consists of placing prominence on the initial syllable: *pròfesóres*, *èmperadór*. Notice that we reserve the term 'emphatic stress' to refer to one of two hypothesized patterns of rhetorical stress. In our usage in this chapter, 'rhetorical stress' is thus a hypernym, covering two hyponyms, i.e. 'rhythmic stress' and 'emphatic stress'.

Quilis (1993: 396) does not make any statements regarding the rules that may govern the distribution of what we are calling 'rhetorical stress', but his examples clearly fall under one or the other of these two patterns, word-initial in *bajo mi rèsponsabilidád* 'under my responsibility' and alternating in *intèrpretáda* 'interpreted', *trabájo de là memória* 'work of memory' (adapted to our notation of stress).

7.3.2 Methods

7.3.2.1 Stimuli and participants

In order to elicit production data for this experiment, recorded utterances were used as oral stimuli. The stimuli consisted of three recorded utterances of the incomplete statement *tenemos alemanes, portugueses*... 'we have Germans, Portuguese...' recorded with different intended patterns of prominence. We will refer to the three stimuli as the 'list', 'rhythmic', and 'emphatic' patterns. The context that was provided in every case was the question: "What nationalities are represented in your company?" The stimuli were produced by the first author and were intended as an incomplete list. The subjects were prompted only with words with two pretonic syllables and were asked to generalize the pattern of prominence to other words with zero, one, two, and three pretonics.

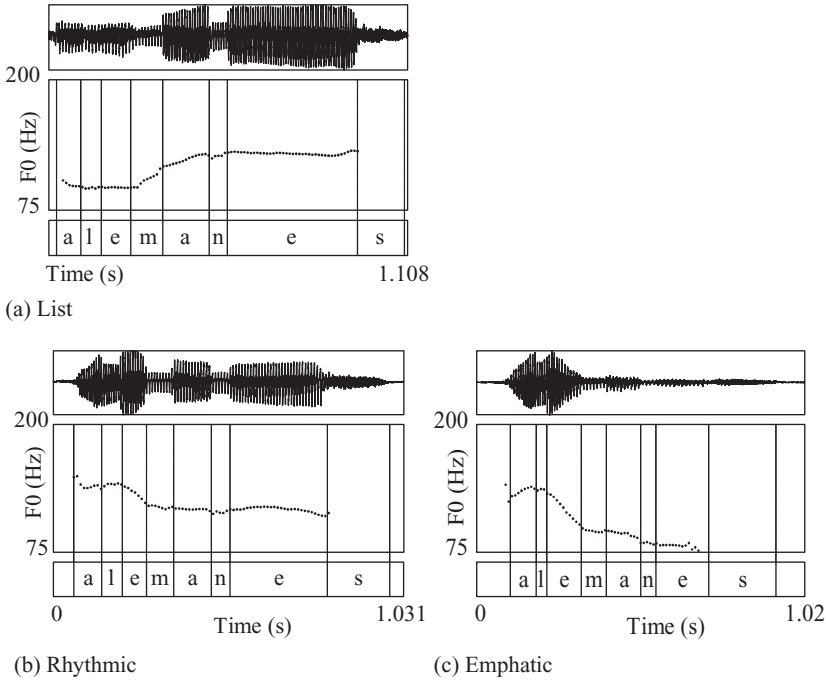


Figure 7.1 Pitch contours of the three tokens of *alemanes* 'Germans' given as aural stimuli: (a) lexical ('list') pattern, (b) 'rhythmic' pattern, (c) 'emphatic' pattern

In the recorded stimulus that we label the 'list' pattern, intended prominence was placed only on the lexically stressed syllable, which is the penultimate syllable of each word. Acoustic inspection of the words *alemánes* and *portuguéses* in this recording reveals a low tone up to the onset of the penultimate syllable, where it rises, remaining high up to the end of the word (because of the continuation rise). There is also a noticeable increase of intensity in the penultimate and final syllables. This is illustrated in the first panel (a) of Figure 7.1, adapted from Hualde (2010).[2]

In the other two aural stimuli there was intended prominence on the initial syllable, *pòrtuguéses, àlemánes*. Notice that since in the stimuli that the participants heard there are exactly two syllables before the lexical stress, the stimuli

[2] Some partial results from this experiment (for four participants), limited to only the case where the lexical stress was on the second syllable, were presented in Hualde (2010), where the issue of clash between primary and secondary stress is considered exclusively. Here we offer a considerably more complete report, including all tested conditions regarding number of syllables. Unlike in Hualde (2010), where no statistical analysis is reported, results from all participants are normalized and presented together here.

are ambiguous between a pattern with initial stress and a pattern with alternating stress. In the 'emphatic' stimulus greater emphasis was placed on this syllable than in the 'rhythmic' style. As can be seen in Figure 7.1, second (b) and third (c) panels, the difference is that in the 'emphatic' stimulus the pitch falls drastically on the second syllable and there is a great reduction in the intensity of the last two syllables of the word, whereas in the 'rhythmic' stimulus there is a smaller pitch fall and intensity remains more stable throughout the word. The hypothesis was that the 'emphatic' stimulus would prompt participants to generalize initial stress in longer words such as *sènegaléses* 'Senegalese', *vènezolános* 'Venezuelans'; whereas the 'rhythmic' stimulus would trigger a binary rhythmic pattern, *senègaléses*, *venèzolános*. In other words, the expectation was that, if produced with the contour in Figure 7.1b, the model ò-o-ó-o would be interpreted as alternating stress and would be generalized as o-ò-o-ó-o in words with three pretonic syllables, whereas the same stress pattern ò-o-ó-o, but produced with greater emphasis on the syllable with non-lexical stress, as in Figure 7.1c, would be interpreted by the subjects as instantiating word-initial stress and thus lead them to produce ò-o-o-ó-o in words with three pretonic syllables.

Participants were asked to read a long list of nationality nouns imitating the prosodic pattern in the stimulus. All the nationality words included in the materials have penultimate stress and have from zero to three pretonic syllables. The complete list of analyzed words is given in Table 7.1 in the 'Appendix'. (Words without pretonic syllables were not analyzed, but are included in the table for reference. The original list also contained additional items containing diphthongs that were not analyzed either.) After listening to the stimulus, participants were prompted to read the complete list imitating the model. Participants were asked to perform this task six times, twice for each of the aural stimuli to be imitated.

Again, the expectation was that, although the 'rhythmic' and 'emphatic' models did not differ in the location of the non-lexical prominence, the 'rhythmic' pattern would trigger rhetorical stress two syllables before the primary, as in *senègaléses*, whereas the 'emphatic' stimulus would produce imitations with initial prominence, *sènegaléses*. For words with only one syllable before the stress, such as *rumános* 'Romanians', the question we asked was whether prominence would be placed on the initial syllable under either the 'rhythmic' or the 'emphatic' pattern, thus producing stress clash. Imitation of the 'list' pattern, on the other hand, was expected not to result in prominence on syllables other than the lexically stressed one.

We have analyzed data from five native speakers of Peninsular Spanish (one male, four female).[3]

[3] An additional female speaker was recorded, but her data were excluded and not analyzed, because during the recording session it became clear that she was not following the instructions.

7.3.2.2 Acoustic and statistical analysis

The vowel of the lexically stressed syllable of each word and that of all preceding syllables within the word were manually segmented. A Praat (Boersma 2001) script written for this purpose returned the maximum F0, mean intensity, and duration of the segmented vowels.

Values were normalized using *z*-score transformation. For each measurement, the mean of all vowels combined and the standard deviation were calculated. The mean was then subtracted from each data point and the result was divided by the standard deviation. The resulting values express *z*-scores (i.e. how many standard deviations away from the mean a given value is). This was done separately for each speaker. Thus, *z*-score normalization is a speaker-intrinsic, but vowel-extrinsic technique (Adank *et al.* 2004).

We divided the data into three subsets, depending on the number of pretonic syllables (one, two, or three). The data were analyzed using linear mixed-effects regression models, with position in the word and style ('emphatic', 'rhythmic', 'list') as fixed effects, and speaker as a random factor. Interactions between the two fixed effects were analyzed by separating the data into three data subsets, depending on style. The posttonic syllable is not included in the analyses. Likewise, as mentioned, words with initial stress were excluded. A total of 1,530 vowel tokens were measured, of which 44 had to be discarded due to creaky voice and other problems (=1,486 tokens included in analyses). Details are given in Table 7.2 in the 'Appendix'.

7.3.3 Results

In the next subsections we present the results of the acoustic and statistical analysis of each of the correlates of stress that were considered: maximum F0, mean intensity, and duration of the vowel in each syllable. Results are presented visually in boxplots separately for words with one, two, and three syllables preceding the lexically stressed one. The labels that we use to identify each of the syllables can be illustrated with the word *senegaléses*:

pppt (preprepretonic) = *se*
ppt (prepretonic) = *ne*
pt (pretonic)= *ga*
str (stressed) = *le*

In the last subsection the results are put together and summarized.

7.3.3.1 Maximum F0

Figure 7.2 shows normalized maximum F0 boxplots for words with one syllable before the primary stress (e.g. *rumános*). Figure 7.3 shows the results for words with two syllables before the primary stress (e.g. *japonéses*

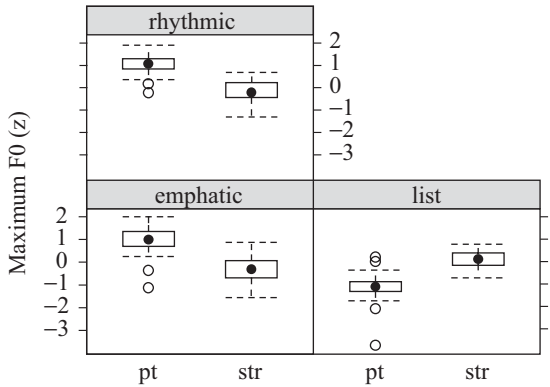


Figure 7.2 Maximum F0 (normalized values) in words with one pretonic syllable

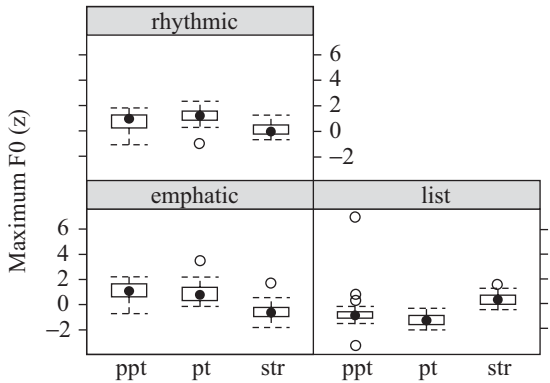


Figure 7.3 Maximum F0 (normalized values) in words with two pretonic syllables

'Japanese') and Figure 7.4 for words with three syllables before the stress (e.g. *senegaléses*).

As shown in the boxplots, whereas in words produced imitating the 'list' pattern there is a rise in pitch coinciding with the lexically stressed syllable, in the other two patterns a peak is reached before the stressed syllable, followed by a drop, so that the pretonic and, in words with two or three syllables before the lexical stress, the pretonic and the prepretonic, have higher pitch than the lexically stressed one. Figure 7.4 shows that, in words with three syllables before the lexical stress, the initial syllable has lower pitch than the next syllable in both the 'emphatic' and the 'rhythmic' style. These results thus show that F0 clearly serves as a cue for rhetorical stress.

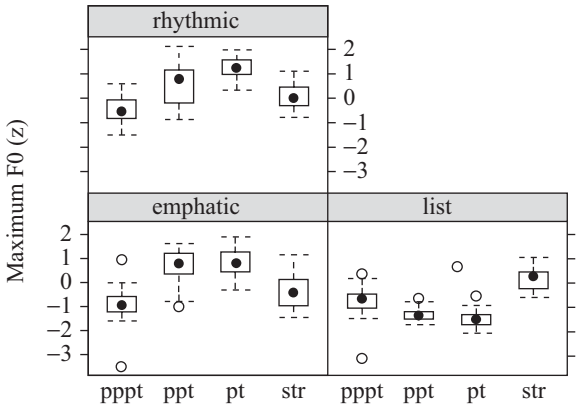


Figure 7.4 Maximum F0 (normalized values) in words with three pretonic syllables

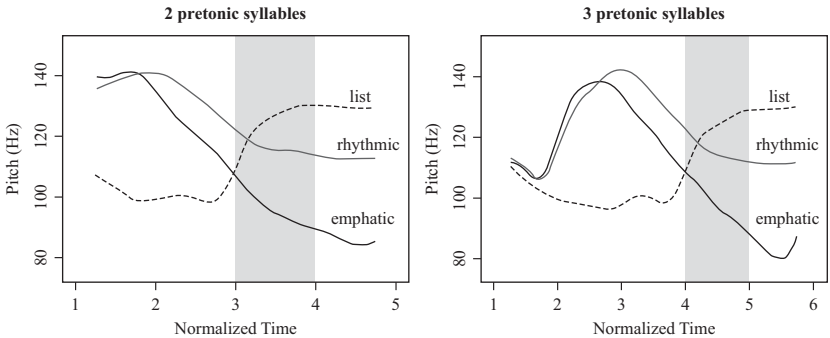


Figure 7.5 Averaged F0 contours for words with two (left panel) and three (right panel) pretonic syllables for our male speaker; the shaded box indicates the location of the stressed syllable

Contrary to our predictions, the 'emphatic' model did not result in rhetorical stress (higher F0) on the initial syllable in words with three syllables before the primary stress. Nevertheless, the participants were able to capture the differences present in the stimuli and produced different tonal patterns. F0 values were taken at 25, 50, and 75 percent of each vowel in the word, including the posttonic. The values were averaged, and the contours were plotted with spline interpolation. Figure 7.5 shows averaged F0 contours for words with two (left) and three (right) pretonic syllables produced by our male speaker. As expected, the F0 decrease after the peak is steeper until the end of the utterance in the 'emphatic' condition. There is also a clear increase in pitch range in the

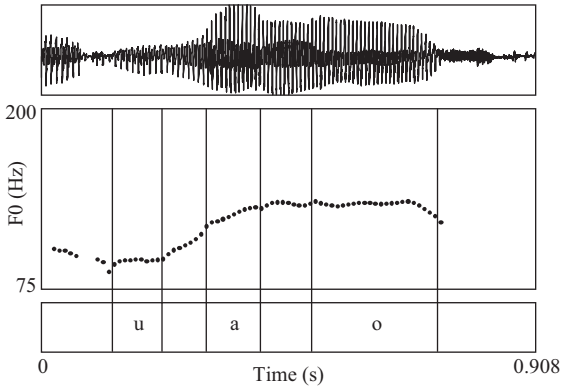
'emphatic' condition with respect to both the 'list' and 'rhythmic' conditions (the difference between the highest peak and lowest valley is of around 60 Hz in the 'emphatic' condition vs. 30 Hz in the 'rhythmic' and 'list' conditions). It is interesting to note that in the condition with three pretonic syllables, which was not modeled in the stimulus, the tonal peak is somewhat earlier in the 'emphatic' condition, even if it is not associated with the initial syllable.

It is also remarkable that a high pitch on the pretonic is also found in words with a single pretonic syllable (Figure 7.2). In Figure 7.6 we show F0 contours for the word *rumános* in the three styles by one of the subjects.

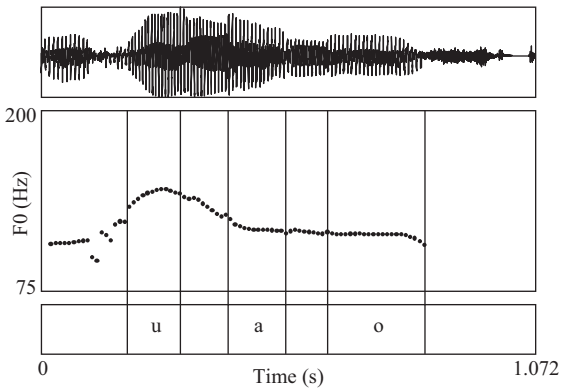
The linear mixed-effects regression model on data with one pretonic syllable (all speakers combined) returned significant effects of position ($F[1,280] = 38.64$, $p > .001$), style ($F[2,280] = 104.49$, $p > .001$), and a significant interaction between position and style ($F[2,280] = 196.88$, $p > .001$). The data were separated into three subsets by style in order to explore the interaction between position and style. The data were submitted to another mixed-effect regression model with the single fixed effect of position and the same random factors. *p*-values were obtained through Markov chain Monte Carlo sampling (Baayen 2008). The stressed vowel has higher maximum F0 than the pretonic vowel in the 'list' condition, whereas the opposite is true in the 'rhythmic' and 'emphatic' conditions (see Table 7.3 in the 'Appendix').

For words with two pretonic syllables, significant effects of position ($F[2,603] = 18.84$, $p > .001$), style ($F[2,603] = 180.09$, $p > .01$), and a significant interaction between position and style ($F[2,603] = 125.01$, $p > .01$) were also found. Table 7.4 in the 'Appendix' presents the results of the new regression models with the single fixed effect of position. In order to be able to investigate the three pair-wise comparisons, for each subset two models were fitted, with different intercepts. Whereas the stressed vowel has the highest maximum F0 in the 'list' style, in the 'rhythmic' and 'emphatic' styles the maximum F0 is located in the pretonic syllables. In the 'rhythmic' condition, the highest peak is found in the immediate pretonic. In the 'emphatic' condition, the maximum F0 in the pretonic and prepretonic vowels is not significantly different, but in both it is higher than in the lexically stressed vowel.

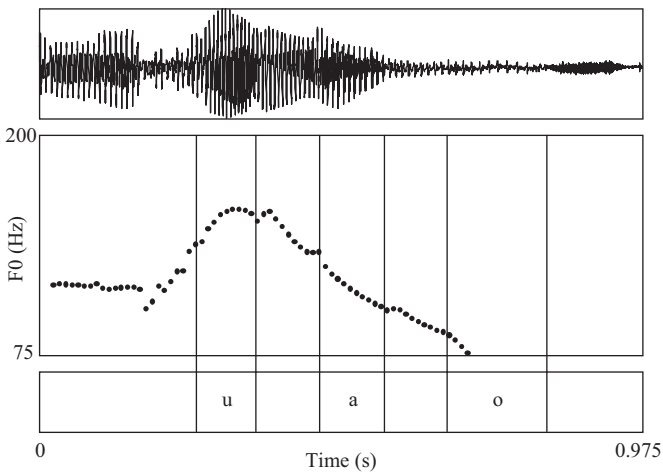
Finally, the analysis of the data with three pretonic syllables also yielded significant effects of position ($F[3,576] = 74.63$, $p > .01$), style ($F[2,576] = 267.38$, $p > .01$), and a significant interaction between both ($F[6,576] = 114.53$, $p > .01$). In the 'list' condition, we observe a decrease in maximum F0 from the preprepretonic to the prepretonic and pretonic (not statistically different, see Table 7.5 in the 'Appendix'), followed by an increase in the stressed vowel, which has the highest maximum F0. In contrast, in the 'rhythmic' condition, there is a progressive increase in maximum F0 from the preprepretonic to the pretonic vowel, and then a decrease with respect to the stressed vowel (all comparisons are significant). This is similar to the pattern in the 'emphatic'



(a) List



(b) Rhythmic



(c) Emphatic

Figure 7.6 Sound waves and pitch contours for three productions of the word *rumanos* 'Romanians' by our male subject; vowels are segmented: (a) 'list' style, (b) 'rhythmic' style, (c) 'emphatic' style

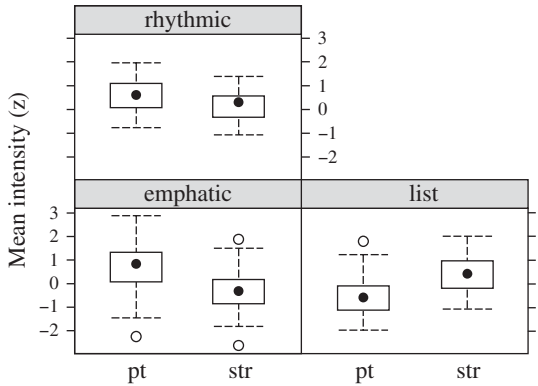


Figure 7.7 Mean intensity (normalized values) in words with one pretonic syllable

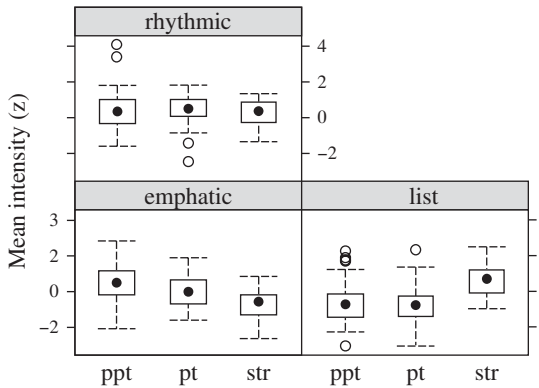


Figure 7.8 Mean intensity (normalized values) in words with two pretonic syllables

condition. In this condition, the difference between the pretonic and prepretonic vowels is not statistically significant, but both present significantly higher maximum F0 than the preprepretonic and the lexically stressed vowels. Notice that the initial syllable does not have higher F0 in Figure 7.4.

7.3.3.2 Mean intensity

The results of our measurement of mean intensity in each of the syllables are visually shown in the boxplots in Figures 7.7 to 7.9.

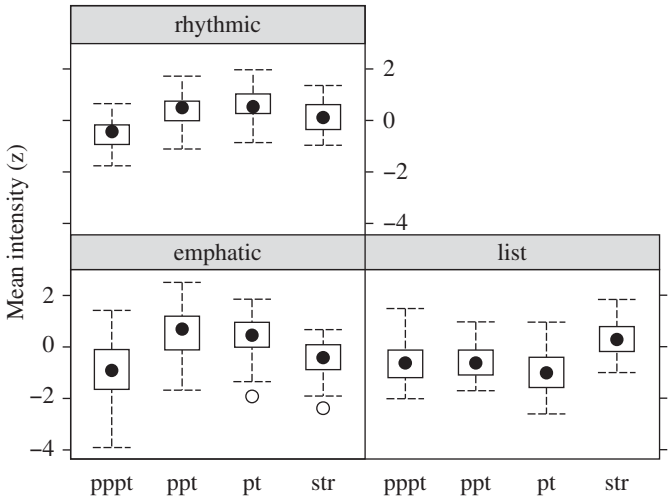


Figure 7.9 Mean intensity (normalized values) in words with three pretonic syllables

The patterns are similar to those obtained for maximum F0. Still, statistical analysis revealed that position was not significant for vowels with one ($F[1,280] = 1.71$, n.s.) and two ($F[2,603] = 2.29$, n.s.) pretonic syllables. The effect of style (one pretonic syllable: $F[2,280] = 8.57$, $p > .001$; two pretonic syllables: $F[2,603] = 23.59$, $p > .001$) and the interaction between position and style (one pretonic syllable: $F[2,280] = 34.72$, $p > .001$; two pretonic syllables: $F[4,603] = 42.61$, $p > .001$) were significant. The analysis with words with three pretonic syllables returned significant main effects of position ($F[3,576] = 31.18$, $p > .001$) and style ($F[2,576] = 30.62$, $p > .001$), as well as a significant interaction ($F[6,576] = 24.56$, $p > .001$) between both. The interaction was explored as before and the results are presented in Table 7.6 in the 'Appendix'. In the 'list' condition, the stressed vowel has higher intensity than the pretonic vowels. The immediate pretonic vowel has lower intensity than the prepretonic and preprepretonic vowels, which do not differ from each other. In the remaining conditions, there is a peak in mean intensity in the pretonic and prepretonic syllables (not different from each other). These have higher intensity than both the preprepretonic (initial) and the lexically stressed vowel.

In summary, although we can observe the same tendencies in intensity variation as for maximum F0, the effect of position is only statistically significant for words with three pretonic syllables, where we obtain the same results as for F0: whereas in the 'list' style intensity peaks in the lexically stressed syllable, in both rhetorical styles there is an intensity maximum in the two syllables preceding the lexically stressed one.

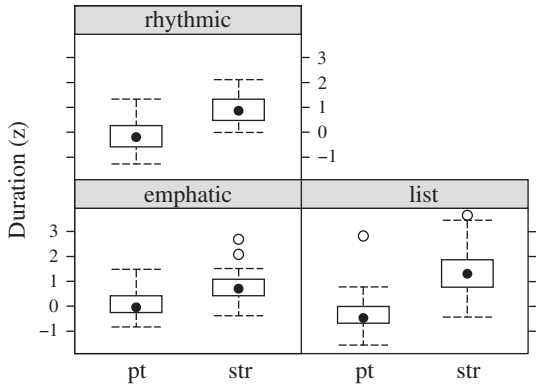


Figure 7.10 Duration (normalized values) in words with one pretonic syllable

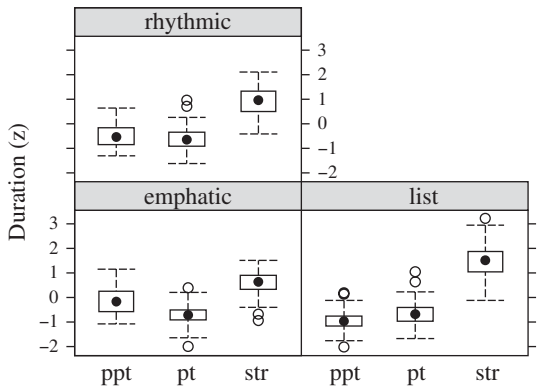


Figure 7.11 Duration (normalized values) in words with two pretonic syllables

7.3.3.3 Duration

In all patterns and regardless of the number of pre-stress syllables, the vowel of the syllable with primary or lexical stress was significantly longer than all preceding vowels in the word. Figures 7.10 to 7.12 show normalized duration boxplots for words with one to three pretonic syllables.

For words with one pretonic syllable, significant effects of position ($F[1,280] = 235.40$, $p > .001$) and a significant interaction between position and style ($F[2,280] = 12.87$, $p > .001$) were found. The effect of style was non-significant ($F[2,280] = 0.78$, n.s.). The interaction was explored as for the other correlates. The stressed vowel is longer than the pretonic vowel in the three styles (see Table 7.7 in the 'Appendix'). Figure 7.10 shows that the difference is emphasized in the 'list' condition.

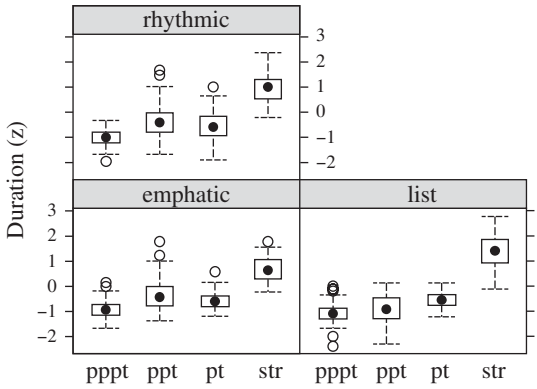


Figure 7.12 Duration (normalized values) in words with three pretonic syllables

Significant effects of position ($F[2,603] = 648.15$, $p > .01$) and a significant interaction between position and style ($F[4,603] = 45.93$, $p > .01$) were also found in the analysis of words with two pretonic syllables. The effect of style was again not significant ($F[2,603] = 0.45$, n.s.). The interaction was explored as before. The results of the models are presented in Table 7.8 in the 'Appendix'. In all conditions, stressed vowels are longer than those in pretonic position. In the 'list' condition, the pretonic vowel is also longer than the prepretonic vowel. That is, there is a progressive increase in duration from the prepretonic vowel to the lexically stressed one. In the 'emphatic' condition, however, the pretonic syllable is shorter than the prepretonic. This is also the pattern for the 'rhythmic' condition (see Figure 7.11), but the difference is not statistically significant.

In words with three pretonic syllables, position ($F[3,576] = 410.04$, $p > .01$), but not style ($F[2,576] = 0.43$, n.s.), was found to have a significant effect on duration. As in the other two contexts, the effect between style and position was significant ($F[6,576] = 15.11$, $p > .001$). As shown in Table 7.9 in the 'Appendix', the lexically stressed vowel is the longest in all three conditions. In the 'list' condition, there is a progression: duration decreases from the lexically stressed to the preprepretonic vowel (see Figure 7.12). All comparisons are significant except for that between prepretonic and preprepretonic vowels. In the 'emphatic' condition, with all comparisons being significant, the prepretonic is longer than both the pretonic and the preprepretonic. This is similar to what we observe in the 'rhythmic' condition, although the comparison between pretonic and prepretonic vowels did not reach significance.

7.3.4. Summary of the results

To summarize the results, rhetorical stress on a pretonic syllable is cued mostly by F0 (partially also by intensity), whereas the lexically stressed syllable

maintains durational prominence. That is, the phenomenon of rhetorical stress results in the addition of prominence to an unstressed syllable, but the lexically stressed syllable does not lose all of its prominence. Different cues are used for rhetorical and lexical stress. Rhetorical stress can be characterized as the anchoring of a pitch-accent on a syllable preceding the lexical stress (see Kimura 2006), whereas the lexically stressed syllable retains durational cues of prominence.

Regarding the distribution of rhetorical stress, in words with two and three pretonic syllables the difference in F0 between the two syllables preceding the lexical accent is small. We conclude that the rhetorical stress is generally placed two syllables before the lexical stress, based both on the fact that that is where the pitch rises and also on durational differences (e.g. *hònduréños* 'Hondurans', *domìnicános* 'Dominicans').

We were unable to find evidence for our hypothesized distinction in pattern of prominence between 'rhythmic' and 'emphatic' stress in our experiment. We conclude that, contrary to our hypothesis, what triggers initial, as opposed to alternating, rhetorical stress is not a greater degree of emphasis. Nevertheless, the overall pitch contours that we obtained in our 'rhythmic' and 'emphatic' conditions presented some differences, with the 'emphatic' condition presenting a wider tonal range and somewhat earlier peaks.

An important finding is that, contrary to all intuition-based descriptions of secondary stress patterns, rhetorical stress on the initial syllable was not avoided by any participant in the experiment when the next syllable carried lexical stress (e.g. *rumános* → *rùmános*).

7.4 Discussion

We have presented an experiment where patterns of rhetorical stress were elicited. Since descriptions of non-primary stress in Spanish posit prominence on either the initial syllable or two syllables before the lexical stress, participants listened to stimuli that were ambiguous between these two patterns (ò-o-ó-o) and were asked to generalize to words with different numbers of pretonic syllables. The hypothesis was that, depending on the degree of emphasis in the stimulus on the syllable with non-lexical prominence, speakers would generalize either initial prominence (ò-o-o-ó-o) or alternating prominence (o-ò-o-ó-o).

This hypothesis was not confirmed. Forms like *sènegaléses* only appeared sporadically in our data, and not in a consistent manner. Instead, speakers preferred to place prominence closer to the lexically stressed syllable. This does not mean that such a pattern, which is the one that Navarro Tomás describes for secondary stress and has been given as an alternative by later authors, does not exist or is anomalous in Spanish. Observation of public speech shows that such a pattern is indeed a possibility in rhetorical speech (e.g. *rèlacionádas* in Belda

Fabregat and de-la-Mota's 2010: Figure 3, from a corpus of radio speech; see also Hualde 2007).

On the other hand, all participants produced prominence on the initial syllable under stress clash, in forms such as *rùmános*. This is not entirely surprising, since observation of naturally occurring rhetorical stress shows that this pattern is not avoided, e.g. the word *Valéncia* will be normally produced with stress clash in a public announcement such as *Pàsajéros con destíno Bàrcelóna, Vàléncia, Tegùcigálpa* 'passengers with destination Barcelona, Valencia, Tegucigalpa' (Hualde 2007, 2009). Notice that this pattern of rhetorical stress shows a rhythmic distribution, even if this rhythm allows primary and secondary stresses on adjacent syllables. In this respect, it is perhaps useful to point out that the English iambic pentameter also allows for stress clashes under certain circumstances (Hammond 1999: 152). Stress clash is thus not incompatible with rhythmicity (see van der Hulst, this volume, chapter 11, on rhythm with clashes). This is, nevertheless, interesting because all existing descriptions of secondary stress in Spanish, from Navarro Tomás (1977[1918]) to Harris (1983) and Roca (1986), reject the pattern ò-ó-o as ill-formed.

This leads us to the question, posited in section 7.1, of what the nature of such descriptions of secondary stress is and how they relate to the phenomenon of rhetorical stress that we have analyzed here.

As Navarro Tomás (1977[1918]: 195) expresses it, in the description of patterns of secondary stress we would be dealing with an intuition of rhythmicity, a perception of alternation between stronger and weaker syllables, triggered perhaps by a complex combination of intensity and other cues. If this were only Navarro Tomás's intuitive feeling, perhaps his description of Spanish patterns of secondary stress could be simply dismissed as unsubstantiated. What makes the issue more interesting is that other authors have reported similar (although, again, not identical) intuitions.

Given the stimuli *àlemánes*, *pòrtuguéses*, the participants in the experiment generally produced the forms *pòlácos* 'Polish', *ìngléses* 'English', *jàponéses* 'Japanese', *àrgentínos* 'Argentinians', *hònduréños* 'Hondurans', *senègaléses* 'Senegalese', *domìnicános* 'Dominicans', etc. The rule that these speakers applied can be stated as follows: "Add prominence (i.e. a pitch accent) two syllables before the lexical stress. If there is only one syllable before the lexical stress, add prominence to that syllable." For clarity, we may compare this pattern with the patterns of secondary stress postulated in the literature:

Experiment	Navarro Tomás	Harris
ò-ó-o	o-ó-o	o-ó-o
ò-o-ó-o	ò-o-ó-o	ò-o-ó-o
o-ò-o-ó-o	ò-o-o-ó-o	ò-o-o-ó-o ~ o-ò-o-ó-o

The patterns obtained in our experiment on rhetorical stress coincide with Navarro Tomás's (1977 [1918]: 195–6) secondary stress only in the case of words with two pretonic syllables. Nevertheless, as mentioned before, the pattern with initial prominence in words with three pretonic syllables has been attested in other work on rhetorical stress using natural data and was also sporadically produced by our subjects. The only real difference with all phonological descriptions of secondary stress, then, is in the case of words with a single pretonic syllable, where our subjects produced a configuration with stress clash.

What is then the connection between secondary stress (an intuition) and rhetorical stress (an empirically verifiable phenomenon)? Rhetorical stress in Spanish appears to have a closer link to rhythmic secondary stress than the analogous phenomenon in Greek studied by Arvaniti (1997), which appears to be determined solely in relation to word boundaries. However, a difference is that stress clash is not avoided for the placement of rhetorical stress when it is the only possibility.

Our experimental materials did not have enough pretonic syllables to permit the presence of more than one stress to the left of the primary. In Hualde's (2007) unquantified observation of public speech it is reported that patterns with more than one non-primary stress in the prosodic word are attested, but infrequent. In Nadeu and Hualde's (2012) study of Catalan radio speech, fifty words with more than one non-primary stress were found (e.g. *còmunìcacións* 'communications'; Figure 3 of that paper) vs. 106 prosodic words with four or more pretonic syllables but with a single non-primary stress. That is, even in rhetorical style, it is more common not to have rhythmic alternation.

The phenomenon of rhetorical stress in Spanish (and Catalan) appears to follow one of two optional rules: (a) place a stress on the initial syllable of the word, e.g. *nàcionalización* 'nationalization'; or (b) place a stress two syllables before the one with lexical stress, *nacionalìzación*. Rule (a) would be an instance of the phenomenon van der Hulst (2012, this volume, chapter 11) calls 'Edge Prominence' or 'polar accent'. In Spanish, there appears to be some optionality regarding what counts as 'word' for rule (a). It may be either the morphological word or the prosodic word, including preceding unstressed function words, e.g. *là nación* 'the nation', *pòr la mañána* 'in the morning'. Rule (a) may result in stress clash in the case where there is a single pretonic syllable. Contrary to all intuition-based descriptions of secondary stress, our experimental results show that there may be stress clash under these conditions even when speakers are applying rule (b).

Rule (b) may be reiterated, if there are enough syllables, creating echo stresses, but, again, this is uncommon, *naciònalìzación* ~ *nàcionalìzación*. The descriptions of secondary stress in Spanish in the literature involving alternating echo stresses from the syllable with primary stress would seem to

refer to a potentiality for the iteration of rule (b). The conflict between rules (a) and (b) would result in the patterns of rhetorical stress that have been attested, as well as the two patterns of secondary stress that have been described by authors such as Harris (1983) and Roca (1986).

Finally, we may remark that, as an optional discourse-level rhythmic phenomenon, rhetorical/secondary stress in Spanish is, in any case, a quite different phenomenon from primary stress, which is lexical, assigned with respect to the end of the word, and sensitive to quantity (at least as a strong tendency).

Both because of the existence of the two rules of rhetorical stress given above (initial vs. two syllables before the primary) and because it operates at the phrasal level, different syllables of the same word may be targeted to receive rhetorical stress on different occasions. This is thus different from the existence of more than one stress in compounds (e.g. *lógicaménte* 'logically', *tranquílaménte* 'calmly'), where the position of the stresses is lexically determined.

This is consistent with van der Hulst's (1997, 2012, this volume, chapter 11) view on primary and secondary stress as independent mechanisms. The connection between primary and secondary stress in Spanish is, of course, that the distribution of secondary stress is based in part on the location of the primary stress (and in part on the location of the beginning of the word).

In our view, both primary and secondary stress may be either lexical or post-lexical, depending on the language. In Spanish, primary stress is a lexical property of words and secondary stress is a post-lexical phenomenon. In French there is only post-lexical prosody. In English, on the other hand, both primary and secondary stress are lexical. Both the unpredictable distribution of secondary stress in English and the fact that the primary stress is not necessarily the last one (e.g. *cantáta* vs. *bàndánna* vs. *cúcùmber*) requires some lexical marking of secondary stress (Hammond 1999: 269, 318; see also Plag *et al.* 2011). For English, but not for Spanish, it makes sense to include primary and secondary stress in the same algorithm.

Appendix

Table 7.1 *Experimental items*

Zero pretonic syllables (not analyzed)	búlgaros, árabes, húngaros
One pretonic syllable	chilenos, franceses, ingleses, polacos, rumanos
Two pretonic syllables	alemanes, argentinos, hondureños, japoneses, mexicanos, panameños, portugueses
Three pretonic syllables	americanos, dominicanos, salvadoreños, senegaleses, venezolanos

Table 7.2 *Distribution and number of analyzed vowel tokens*

Word type	Number of vowels collected	Number of vowels discarded due to creaky voice or data-acquisition problems
One pretonic syllable	300 = 5 words * 2 positions * 3 patterns * 2 repetitions * 5 speakers	14 (produced by our male speaker)
Two pretonic syllables	630 = 7 words * 3 positions * 3 patterns * 2 repetitions * 5 speakers	18 (15 produced by our male speaker)
Three pretonic syllables	600 = 5 words * 4 positions * 3 patterns * 2 repetitions * 5 speakers	12 (produced by our male speaker)

Table 7.3 *Results of the mixed-effects regression models with maximum F0 as response and with the single fixed effect of position; one pretonic syllable*

	Intercept	Comparison	β-value	*t*-value	*p*-value
List	stressed	pretonic	– 1.23	– 12.87	< .001
Rhythmic	stressed	pretonic	1.15	13.16	< .001
Emphatic	stressed	pretonic	1.31	11.14	< .001

Table 7.4 *Results of the mixed-effects regression models with maximum F0 as response and the single fixed effect of position; two pretonic syllables*

	Intercept	Comparison	β-value	*t*-value	*p*-value
List	stressed	pretonic	– 1.62	– 13.20	< .001
		prepretonic	– 1.08	– 8.83	< .001
	pretonic	prepretonic	0.53	4.36	< .001
Rhythmic	stressed	pretonic	1.10	11.25	< .001
		prepretonic	0.68	6.95	< .001
	pretonic	prepretonic	– 0.42	– 4.31	< .001
Emphatic	stressed	pretonic	1.50	12.64	< .001
		prepretonic	1.63	13.73	< .001
	pretonic	prepretonic	0.13	1.09	n.s.

Table 7.5 *Results of the mixed-effects regression models with the single fixed effect of position; three pretonic syllables*

	Intercept	Comparison	β-value	*t*-value	*p*-value
List	stressed	pretonic	– 1.66	– 20.99	< .001
		prepretonic	– 1.53	– 19.36	< .001
		preprepretonic	– 0.92	– 11.61	< .001
	pretonic	prepretonic	0.13	1.63	n.s.
		preprepretonic	0.74	9.38	< .001
	prepretonic	preprepretonic	0.61	7.75	< .001
Rhythmic	stressed	pretonic	1.15	10.92	< .001
		prepretonic	0.52	4.97	< .001
		preprepretonic	– 0.57	– 5.37	< .001
	pretonic	prepretonic	– 0.63	– 5.95	< .001
		preprepretonic	– 1.72	– 16.29	< .001
	prepretonic	preprepretonic	– 1.09	– 10.34	< .001
Emphatic	stressed	pretonic	1.23	9.47	< .001
		prepretonic	1.07	8.25	< .001
		preprepretonic	– 0.52	– 3.97	< .001
	pretonic	prepretonic	– 0.16	– 1.22	n.s.
		preprepretonic	– 1.75	– 13.44	< .001
	prepretonic	preprepretonic	– 1.59	– 12.22	< .001

Table 7.6 *Results of the mixed-effects regression models with the single fixed effect of position; three pretonic syllables*

	Intercept	Comparison	β-value	*t*-value	*p*-value
List	stressed	pretonic	– 1.35	– 9.44	< .001
		prepretonic	– 0.92	– 6.43	< .001
		preprepretonic	– 0.92	– 6.42	< .001
	pretonic	prepretonic	0.43	3.01	< .01
		preprepretonic	0.43	3.02	< .01
	prepretonic	preprepretonic	0.00	0.01	n.s.
Rhythmic	stressed	pretonic	0.39	3.16	< .01
		prepretonic	0.28	2.24	< .05
		preprepretonic	– 0.69	– 5.58	< .001
	pretonic	prepretonic	– 0.11	– 0.92	n.s.
		preprepretonic	– 1.09	– 8.74	< .001
	prepretonic	preprepretonic	– 0.97	– 7.81	< .001
Emphatic	stressed	pretonic	0.73	4.57	< .001
		prepretonic	0.96	5.95	< .001
		preprepretonic	– 0.50	– 3.10	< .01
	pretonic	prepretonic	0.22	1.39	n.s.
		preprepretonic	– 1.23	– 7.66	< .001
	prepretonic	preprepretonic	– 1.46	– 9.05	< .001

Table 7.7 *Results of the mixed-effects regression models with the single fixed effect of position; one pretonic syllable*

	Intercept	Comparison	β-value	*t*-value	*p*-value
List	stressed	pretonic	– 1.67	– 10.67	< .001
Rhythmic	stressed	pretonic	– 1.10	– 10.48	< .001
Emphatic	stressed	pretonic	– 0.71	– 6.08	< .001

Table 7.8 *Results of the mixed-effects regression models with the single fixed effect of position; two pretonic syllables*

	Intercept	Comparison	β-value	*t*-value	*p*-value
List	stressed	pretonic	– 2.11	– 23.54	< .001
		prepretonic	– 2.44	– 27.14	< .001
	pretonic	prepretonic	– 0.32	– 3.60	< .001
Rhythmic	stressed	pretonic	– 1.51	– 18.17	< .001
		prepretonic	– 1.37	– 16.53	< .001
	pretonic	prepretonic	0.14	1.64	n.s.
Emphatic	stressed	pretonic	– 1.29	– 14.90	< .001
		prepretonic	– 0.76	– 8.74	< .001
	pretonic	prepretonic	0.53	6.17	< .001

Table 7.9 *Results of the mixed-effects regression models with the single fixed effect of position; three pretonic syllables*

	Intercept	Comparison	β-value	*t*-value	*p*-value
List	stressed	pretonic	– 1.97	– 20.09	< .001
		prepretonic	– 2.27	– 23.13	< .001
		preprepretonic	– 2.45	– 24.99	< .001
	pretonic	prepretonic	– 0.30	– 3.04	< .01
		preprepretonic	– 0.48	– 4.90	< .001
	prepretonic	preprepretonic	– 0.18	– 1.86	n.s.
Rhythmic	stressed	pretonic	– 1.42	– 13.80	< .001
		prepretonic	– 1.33	– 12.90	< .001
		preprepretonic	– 1.92	– 18.62	< .001
	pretonic	prepretonic	0.09	0.90	n.s.
		preprepretonic	– 0.50	– 4.83	< .001
	prepretonic	preprepretonic	– 0.59	– 5.73	< .001
Emphatic	stressed	pretonic	– 1.23	– 12.51	< .001
		prepretonic	– 0.97	– 9.90	< .001
		preprepretonic	– 1.47	– 14.97	< .001
	pretonic	prepretonic	0.26	2.61	< .01
		preprepretonic	– 0.24	– 2.46	< .05
	prepretonic	preprepretonic	– 0.50	– 5.07	< .001

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Part III

The analysis of stress types / stress phenomena

8 Culminativity times harmony equals unbounded stress

Jeffrey Heinz

8.1 Introduction

Well-studied computational representations of stress patterns are desirable in phonological analysis for several reasons.* Perhaps the most important one is that they reveal insights which are (i) relevant to *any* particular theory of phonology and (ii) otherwise difficult to divine. This is because these representations highlight the importance of *what* is being computed and are less concerned with *how* it is being computed. This chapter demonstrates one example of this by showing concretely how once culminativity is factored out, simple unbounded stress patterns over syllables are of the same formal character as simple harmony systems over consonants and vowels. This analysis thus shows that long-distance phenomena in two seemingly different domains are actually of the same kind.

This chapter defines culminativity as 'exactly one stress per word', which is one way in which the term has been understood in the past (see, for example, Hayes 1995). In other words, culminativity here encompasses *both* the 'obligatory' (at least one stress per word) and 'culminative' (at most one stress per word) properties discussed by Hyman (this volume).

This chapter begins by reviewing what is known about unbounded stress patterns, and then explains the advantages of such computational representations. Next, this chapter reviews simple segmental harmony systems and their computational representations. Finally, it is shown how factoring culminativity out of the unbounded stress patterns yields patterns of the same formal character as simple segmental harmony systems. An 'Appendix' is included which precisely defines the formalisms used in this chapter.

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8.2 Stress patterns

Cross-linguistic investigations of the dominant stress patterns in languages have typically focused on predicting the location of stresses given the syllabic make-up of words (Hyman 1977; Halle and Vergnaud 1987; Idsardi 1992; Hayes 1995; Goedemans *et al*. 1996; Tesar 1998; Gordon 2002; van der Hulst *et al.* 2010). To illustrate, let L and H denote *light* and *heavy* syllables, respectively. Consider a word with the syllable profile L H H. Latin predictably assigns stress to such words to the penultimate syllable (Jensen 1974; Odden 1994), whereas Yapese predictably assigns stress to the final syllable (Jensen 1977).[1]

Both Latin and Yapese may have some words which are unexpected exceptions to the rule. Nonetheless, phonologists have identified the generalization "If the penult is a heavy syllable then it gets stress" as capturing part of the stress rule in Latin. Similarly, the rule "If the final syllable is heavy then it gets stress" is a crucial part of the generalization which describes the dominant stress pattern of Yapese. Lexical exceptions are usually noted in typological analyses, even if the analyses themselves do not address them directly. Following these earlier studies, this chapter likewise abstracts away from lexical exceptions and other such variation in order to focus exclusively on the nature of the generalizations.

8.3 Unbounded stress patterns and computational analysis

Unbounded stress patterns can be defined as those where the generalization describing primary stress placement within some domain does not require that stress fall within a certain fixed distance of either edge of the domain. Unbounded analyses of the stress pattern of several languages have been presented, including Amele, Kwakwala, Chuvash, and Golin (Hayes 1995). As an example, consider the unbounded stress pattern in Kwakwala (Walker 2000).

(1) Primary stress falls on the leftmost heavy syllable in a word, and if there are no heavy syllables, on the final syllable.

Following Hayes (1995), I will refer to this pattern as the 'Leftmost Heavy Otherwise Rightmost' (LHOR) pattern. According to (1), in words with syllable profiles LLH, LLHL, and LLHLH, the primary stress will always fall on the third syllable because that is the leftmost heavy syllable in each word. Table 8.1 shows all words up to four syllables in length which exemplify this pattern. This pattern is unbounded because the primary stress could fall arbitrarily far from

[1] In Latin, syllables with codas and long vowels are considered heavy, whereas in Yapese only syllables with long vowels are heavy. Although which syllables are heavy and light is determined on a language-specific basis, such determinations are not wholly arbitrary. Readers are referred to Gordon (2006) for factors which determine syllable weight.

Table 8.1 *All LHOR words up to four syllables in length*

H́	Ĺ	H́ L	H́ H	L H́
L Ĺ	H́ L L	H́ L H	H́ H L	H́ H H
L H́ L	L H́ H	L L Ĺ	L L H́	L H́ L L
L H́ L H	H́ L L L	H́ L L H	H́ H L L	H́ H L H
L H́ H L	L H́ H H	H́ L H L	H́ L H H	H́ H H L
H́ H H H	L L H́ L	L L H́ H	L L L Ĺ	L L L H́

either word edge. For example, in words with the syllable profile LLLHLLH, stress is predicted to fall on the fourth syllable.

It is important to realize that the generalization in (1) applies equally well to longer words, like the one just given, even if no such words of that length exist in the lexicon (or are constructible by word-formation rules). For the same reason that a rule of word-final obstruent devoicing applies equally well to words hundreds of syllables long as it does to words one syllable in length, there are infinitely many logically possible words which obey the LHOR pattern. The words in Table 8.1 are just among the shortest words drawn from this set. In other words, in every case, the generalizations that phonologists make when describing the competence of native speakers with respect to the dominant stress patterns in languages can be thought of as infinite sets. Our interest in the nature of these phonological generalizations leads us to examine the nature of these mathematical objects – the infinite sets with which these generalizations are identified.

Theoretical computer science provides mathematically rigorous ways to classify sets of infinite size (Harrison 1978). For example, the Chomsky Hierarchy classifies all logically possible sets into the following nested regions.

(2) finite ⊂ regular ⊂ context-free ⊂ context-sensitive ⊂ recursively enumerable

Each of these regions has multiple, independently motivated, converging characterizations which makes these boundaries useful in pattern classification (Harrison 1978; Hopcroft *et al.* 2001).

Interestingly, there are no attested stress patterns which are non-regular. All known stress patterns belong to the *regular* region (Heinz 2009) and thus 'being regular' is a *universal* property of known stress patterns. 'Being regular' means the infinite sets of words which exemplify these patterns can be represented exactly with certain kinds of grammar.

I will use different grammatical formalisms in this chapter, but I will make special use of *finite-state acceptors* (FSAs). Any regular set can be represented

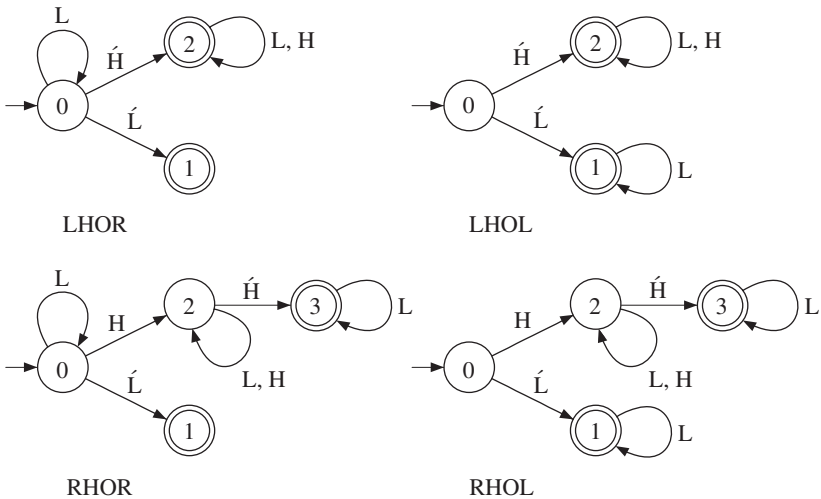


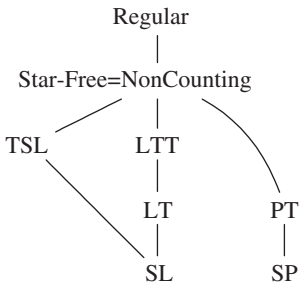
Figure 8.1 Finite-state acceptors for the four basic unbounded stress patterns

exactly with a finite-state acceptor[2] and they can be manipulated in well-understood ways (Hopcroft *et al.* 2001). One such manipulation, the product operation, plays a key role and will be discussed in section 8.6. (The 'Appendix' defines formal languages, finite-state acceptors, and the product operation.)

Representing the phonological generalizations with finite-state acceptors emphasizes that any grammar only ever need distinguish finitely many states even though the generalizations describe infinite sets. The states in these acceptors can be thought of as a kind of memory. Each state identifies some kind of information that is important to keep track of. To illustrate, Figure 8.1 shows finite-state acceptors for each of the four basic types of unbounded stress pattern.

It is important to see how the finite-state representation relates to the words exemplifying each pattern. Consider the acceptor for LHOR shown in Figure 8.1 and imagine a pebble placed on state 0. This state has an incoming arrow from the left, which indicates this is the *initial* state. Now one can move the pebble along any transition emanating from state 0. As one moves the pebble along a particular transition, the label of that transition is written out. (Some transitions in the acceptors above have more than one label separated by commas, in which case one may choose which label gets spelled out.) When the pebble is in a state with two double circles the process may end. Such states are called *final* states. For example, in acceptor LHOR in Figure 8.1, states 1 and 2 are

[2] In fact, this can be taken to be their defining property.



Key	
TSL	Tier-based Strictly Local
LTT	Locally Threshold Testable
LT	Locally Testable
SL	Strictly Local
PT	Piecewise Testable
SP	Strictly Piecewise

Figure 8.2 Proper inclusion relationships among subregular language classes (indicated from top to bottom)

final states. Once the pebble is finished moving, one can see which word has been spelled out. The acceptor is said to *accept*, or equivalently *generate* or *recognize*, every word that can be spelled out by a pebble which begins at the initial state and ends at any final state.

For example, beginning in state 0, let us move the pebble along the arc labeled 'L', which brings the pebble back to state 0. Next, we move the pebble along the arc labeled 'H' to bring it to state 2. Lastly we move it along the arc labeled 'H' to bring it to state 2 again. Here we decide to stop since state 2 is a final state. The word that has been spelled out is 'LH́H' which exemplifies the LHOR pattern. A little experimentation will show that every word which exemplifies the LHOR pattern can be generated by the LHOR acceptor and every word which does not cannot be generated by this acceptor.

The above procedure inadvertently suggests that the FSAs are modeling language processing as opposed to speakers' competence. While the above FSAs could be used as a processing model, that is not how they are being used here. Here, they are being used solely to represent an infinite set that faithfully captures the relevant phonological generalization.

The hypothesis that all humanly possible stress patterns are regular is thus well supported, since all known stress patterns can be described with finite-state acceptors of the above type. This hypothesis should not be misunderstood to mean that any regular pattern is a possible stress pattern. On the contrary, the claim is that 'being regular' is a *necessary* property, but not a *sufficient* one (Heinz 2011a, 2011b).

Much stronger hypotheses can be formulated. There are several *subregular* regions which have been defined according to established language-theoretic, logical, and cognitive criteria (McNaughton and Papert 1971; Simon 1975; Rogers *et al.* 2010; Rogers and Pullum 2011). The most important of these, and their relationships to each other, are shown in Figure 8.2.

It is possible to classify stress patterns according to these regions, which provides a measure of pattern complexity. In typological analysis, such measures are invaluable: for example, the number of phonemes in a language provides a measure of how complex its inventory is (Maddieson 1984, 1992). Since stress patterns describe infinitely sized sets, established complexity measures like the ones provided by the subregular hierarchies in Figure 8.2 are invaluable.

To illustrate, consider the Strictly Local languages. Informally, these languages are those which can be described in terms of a finite set of *permissible* sequences of symbols of length k (in which case we call the language Strictly k-Local). Consider the simple stress pattern which places primary stress on the first syllable and places no secondary stress. This pattern, for example, can be described by a set of permissible sequences of length two. These are {#σ́, σ́σ, σσ, σ# σ́#} where # indicates a word boundary. Every sequence of length two in every word which obeys the ''stress initial syllable' rule is drawn from this set. The 2-length sequences of the word σ́σ, for example, are {#σ́, σ́σ, σ#}, which are all permissible. Therefore it can be said that this pattern is Strictly 2-Local. (Strictly Local languages are defined in the 'Appendix'.)

As an exercise, the reader is encouraged to verify that the stress patterns which place primary stress on the peninitial syllable cannot be described with a set of permissible sequences of length two, but can be described with a set of permissible sequences of length three. Therefore, the peninitial stress pattern is Strictly 3-Local. Also, the unbounded patterns above cannot be described with any finite set of permissible sequences of length k for any k. Readers are referred to Rogers and Pullum (2011) for an accessible introduction to these subregular classes and to McNaughton and Papert (1971), Rogers *et al.* (2010), and Heinz *et al.* (2011) for more detailed treatments of these and other classes in the subregular hierarchies.

Some work has already begun to classify stress patterns with respect to these hierarchies. Edlefsen *et al.* (2008) examines the stress patterns in the stress typology in Heinz (2009) with respect to the Strictly Local languages. They report that 72 percent are SL_k for $k \leq 6$ (the other 28 percent are not SL for any k) and 49 percent are SL_3.

Graf (2010) provides a formal analysis of the stress patterns of Creek and Cairene Arabic, as they have been characterized in the literature. According to Graf's analysis, these stress patterns are not star-free, under the assumption that there is no secondary stress in these languages, which is a contentious issue.

The language classes in Figure 8.2 are not the only subregular classes. For example, Heinz (2009) finds that nearly all stress patterns are neighborhood-distinct, which is a class of formal languages which cross-cuts the subregular hierarchies in Figure 8.2.

Apart from providing established, universal measures of pattern classification, and from allowing strong hypotheses regarding universal properties of stress patterns to be stated, there are other advantages to computational representations of stress patterns.

First, both *SPE*-style and OT-style grammars can be converted into finite-state transducers (Johnson 1972; Kaplan and Kay 1994; Eisner 1997; Frank and Satta 1998; Karttunen 1998; Riggle 2004). Transducers describe input/output mappings as opposed to sets of well-formed words.[3] To illustrate, consider an OT analysis of the LHOR pattern. This analysis describes an input/output mapping, and the set of outputs is *exactly the same* as the one generated by the LHOR acceptor in Figure 8.1.

Consequently, finite-state grammars are a *lingua franca* in which different phonological analyses developed in different grammatical frameworks can be compared. Readers are referred to Heinz (2011a, 2011b) for an overview of this literature, to Beesley and Kartunnen (2003) for a more detailed and technical but still accessible introduction, and to Kaplan and Kay (1994) and Riggle (2004) for technical details.

Second, finite-state representations and algorithms are easy, efficient, and sufficiently powerful to automatically compute the predicted locations of stress given the syllabic make-up of a word, and to generate lists of words exemplifying the pattern. This can be used to check predictions of a theory against existing data. These features are implemented on the online stress pattern database maintained by the author at http://phonology.cogsci.udel.edu/dbs/stress/, and are planned to be included in the next version of StressTyp (Goedemans *et al.* 1996; van der Hulst *et al.* 2010).

Also, these representations are standardly used in many distinct fields. This allows stress patterns to be immediately accessible to researchers in other communities, such as computer science, computational linguistics, and computational biology.

Perhaps most important, however, is that these representations can lead to new insights about the nature of phonological generalizations. This chapter presents an example of this by revealing exactly how simple unbounded stress patterns and simple segmental harmony patterns are the same and how they are different. In fact, the only difference between the two kinds of pattern is that stress patterns are *culminative*, whereas segmental harmony patterns are not. Once culminativity is factored out, the two kinds of long-distance pattern are formally identical.

[3] Finite-state transducers describe *regular* relations – sets of input/output pairs. The set of pairs is regular like the sets of words considered in this chapter because they share the crucial computational property that they can be described with machines which possess only finitely many states (acceptors and transducers both being a kind of machine).

8.4 Long-distance sound patterns

Much research in phonology is devoted to studying the nature of long-distance sound patterns in the world's languages, in particular consonantal harmony (Hansson 2001; Rose and Walker 2004) and vowel harmony (van der Hulst and van de Weijer 1995; Archangeli and Pulleyblank 2007). In this chapter, we are concerned only with simple harmony systems, and set aside harmony systems with neutral elements, such as vowel harmony patterns with transparent and opaque vowels.

As an example, (3) and (4) provide examples of simple vowel harmony and consonantal harmony patterns, respectively. (3) illustrates how in Degema there are no words with both advanced ([i u e o ə]) and retracted ([ɪ ʊ ɛ ɔ a]) vowels. Every vowel in every word agrees in the feature ATR.

(3) ATR harmony in Degema (Archangeli and Pulleyblank 2007, citing Elugbe 1984, Kari 1995, 1997)

Advanced		Retracted	
u-bí-ə̄	'state of being black'	á-kī	'pot'
u-pú-ə̄m	'closing'	ʊ-fʊ́-ā	'state of being white'
u-dér-ə̄m	'cooking'	ɔ-ɗɛ́ɗɛ̄	'chief'
i-sór-ə̄	'passing liquid faeces'	ʊ-bɔ̄m-ām	'beating'
o-gədəgə́	'mighty'	ɔ-kpakɪraká	'tough'

(4) illustrates a similar phenomenon in Samala Chumash. Due to a rule of regressive harmony, there are no words on the surface that include both alveolar ([s sˀ sʰ t͡s t͡sˀ t͡sʰ]) and post-alveolar ([ʃ ʃˀ ʃʰ t͡ʃ t͡ʃˀ t͡ʃʰ]) sibilants and affricates.

(4) Samala Chumash regressive sibilant harmony (Applegate 1972)

Alveolar		
/s-api-t͡ʃʰo-us/	sapit͡sholus	'he has a stroke of good luck'
/s-iʃ-tiʃi-jep-us/	sistisijepus	'they (2) show him'
Post-alveolar		
/s-api-t͡ʃʰo-us-waʃ/	ʃapit͡ʃʰoluʃwaʃ	'he had a stroke of good luck'
/ha-s-xintila-waʃ/	haʃxintilawaʃ	'his former Indian name'

Because harmony patterns permit agreement between potentially unboundedly many segments (cf. Samala Chumash *ʃtoyonowonowaʃ* 'it stood upright'; Applegate 1972: 72), they are similar to unbounded stress patterns in that the distance between certain linguistic units in featural agreement appears unbounded.

Heinz (2007, 2010a) shows that consonantal harmony patterns belong to the Strictly Piecewise (SP) languages (see Figure 8.2). Languages in this class

make distinctions on the basis of (potentially discontiguous) *subsequences* of length *k*. A string is a subsequence of another string only if its symbols occur in order in the other string. For example, both *ʃʃ* and *twoʃ* are subsequences of *ʃtoyonowonowaʃ*. Informally, Strictly 2-Piecewise languages are those which can be described by grammars which are sets of forbidden subsequences of length two. (Strictly Piecewise languages are defined formally in the 'Appendix' in terms of *permissible* subsequences.) Here, I limit discussion to the case when $k = 2$; i.e. to the Strictly 2-Piecewise languages.[4]

To illustrate a Strictly 2-Piecewise language, consider the Samala Chumash example in (4). What formal language describes the surface sibilant harmony pattern? Heinz (2010a) shows that it is exactly that language whose words do not contain disagreeing sibilants as a subsequence of length two. In other words, in Samala Chumash, the subsequences [sʃ] and [ʃs] are *forbidden*. More generally, all strings of length two which match the feature bundles [+strident,αanterior][+strident,−αanterior] are forbidden as subsequences in words in Samala Chumash. To facilitate notation, I will use *s* as an abbreviation for [+strident,+anterior], *ʃ* for [+strident,−anterior], *T* for [+consonantal,−strident], and *V* for [+syllabic].

The language this grammar generates is simply all the logically possible words which do not contain any forbidden subsequence. Every sequence of length two which is not forbidden is called *permissible*. Thus, in Samala Chumash the forbidden subsequences are {sʃ, ʃs} and the permissible subsequences are everything else; that is, {sT, sV, ʃT, ʃV, Ts, Tʃ, TV, TT, Vs, Vʃ, VT, VV}. Equivalently, a Strictly 2-Piecewise language can be described as all and only those words which contain only its permissible subsequences.

Similarly, ATR harmony in Degema forbids subsequences of length two with exactly one advanced and exactly one retracted vowel; i.e. every pair that matches [+syllabic,αATR][+syllabic,−αATR]. Every other subsequence of length two is permissible; i.e. every pair of phones that matches either [αATR][αATR], [+syllabic][+consonantal], or [+consonantal][+syllabic].[5]

Rogers *et al.* (2010) show how to construct a finite-state acceptor which generates exactly the same infinite set as the one generated by a SP grammar, given as a list of forbidden subsequences. I will not discuss this process here, but the reader can verify that the acceptor in Figure 8.3 shows the acceptor

[4] Heinz (2007, 2010a) originally called this class of languages the 'Precedence languages'. The term 'Strictly Piecewise' comes from formal language theory and emphasizes the similarities this class has to the Strictly Local languages on the one hand, and the Piecewise Testable languages on the other (Rogers *et al.* 2010; Heinz and Rogers 2010).

[5] The notion of subsequence at first blush appears similar to Vergnaud's (1977) notion of projection, which, for example, was used by Hayes and Wilson (2008) for learning long-distance phonotactic patterns. However, there are significant differences; see Heinz (2010a) for discussion and Heinz *et al.* (2011) for mathematical details.

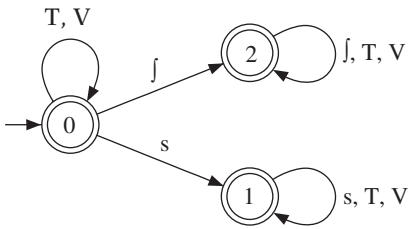


Figure 8.3 An acceptor which recognizes the sibilant harmony pattern in Samala Chumash

which accepts all and only those words which do not contain the forbidden subsequences {sʃ, sʃ}.

Heinz (2010a) is clear that the Strictly 2-Piecewise language describing the sibilant harmony pattern is not intended to accept only possible words of Samala Chumash. It is intended only to capture the long-distance dependency between sibilants in Samala Chumash. This is why the acceptor in Figure 8.3 accepts impossible Samala Chumash words like [ʃkkllkkʃ]. This logically possible word obeys the sibilant harmony generalization. Other aspects of Samala Chumash phonotactics, such as its syllable structure, are captured by other generalizations – formal languages / infinite sets – which can also be represented by other finite-state acceptors. The word [ʃkkllkkʃ] does not obey these generalizations and would not be included in the infinite set of words that do.

In other words, the possible Chumash words are those which obey every phonotactic generalization. This set of words would be exactly those formed by the intersection of the infinite sets describing each individual generalization. Intersection of regular sets can be computed via the acceptor product operation, discussed later in this chapter.

Now we have reached a critical juncture and can pose a very interesting question. Can the unbounded stress patterns also be described with grammars that forbid certain subsequences? To determine whether this is possible, it is necessary to identify the permissible and forbidden subsequences of length two for each unbounded stress pattern. For example, in the LHOR pattern, an unstressed heavy syllable may be followed by another unstressed heavy syllable, but not by a heavy syllable bearing primary stress. In other words, the subsequence HH is permissible and HH́ is forbidden.

Table 8.2 *The permissible and forbidden subsequences for each of the unbounded stress patterns*

LHOR		LHOL	
Permissible	Forbidden	Permissible	Forbidden
L L	Ĺ L	L L	L Ĺ
L Ĺ	Ĺ Ĺ	Ĺ L	Ĺ Ĺ
L H	Ĺ H	L H	Ĺ H
L Ḿ	Ĺ Ḿ	L Ḿ	Ĺ Ḿ
H H	H Ḿ	H H	H Ḿ
H L	H Ĺ	H L	H Ĺ
Ḿ H	Ḿ Ḿ	Ḿ H	Ḿ Ḿ
Ḿ L	Ḿ Ĺ	Ḿ L	Ḿ Ĺ
RHOR		**RHOL**	
Permissible	Forbidden	Permissible	Forbidden
L L	Ĺ L	L L	L Ĺ
L Ĺ	Ĺ Ĺ	Ĺ L	Ĺ Ĺ
L H	Ĺ H	L H	Ĺ H
L Ḿ	Ĺ Ḿ	L Ḿ	Ĺ Ḿ
H H	Ḿ H	H H	Ḿ H
H L	H Ĺ	H L	H Ĺ
H Ḿ	Ḿ Ḿ	H Ḿ	Ḿ Ḿ
Ḿ L	Ḿ Ĺ	Ḿ L	Ḿ Ĺ

In fact, the Strictly 2-Piecewise languages permit the expression of the generalization "No more than one primary stress exists within a word". For example, by forbidding subsequences such as {ĹĹ, ĹḾ, ḾĹ, ḾḾ}, it is possible to ensure that at most one primary stress occurs in a word.

Table 8.2 shows the permissible and forbidden subsequences for each unbounded stress pattern. As discussed above, the sets of permissible and forbidden factors can be thought of as grammars that accept all and only those logically possible words which contain only permissible subsequences (or equivalently, which do not contain any of the forbidden subsequences).

Using the algorithm given in Rogers *et al.* (2010), I computed the finite-state acceptors which recognizes exactly the same language as these grammars in Table 8.2. These are shown in Figure 8.4.

These acceptors – which I will call the SP versions of the unbounded patterns – are not the same as the ones in Figure 8.1. For example, each of the acceptors accepts the string LLLLL, which carries no stress at all. Why is this? The reason is straightforward. For every one of the four unbounded stress

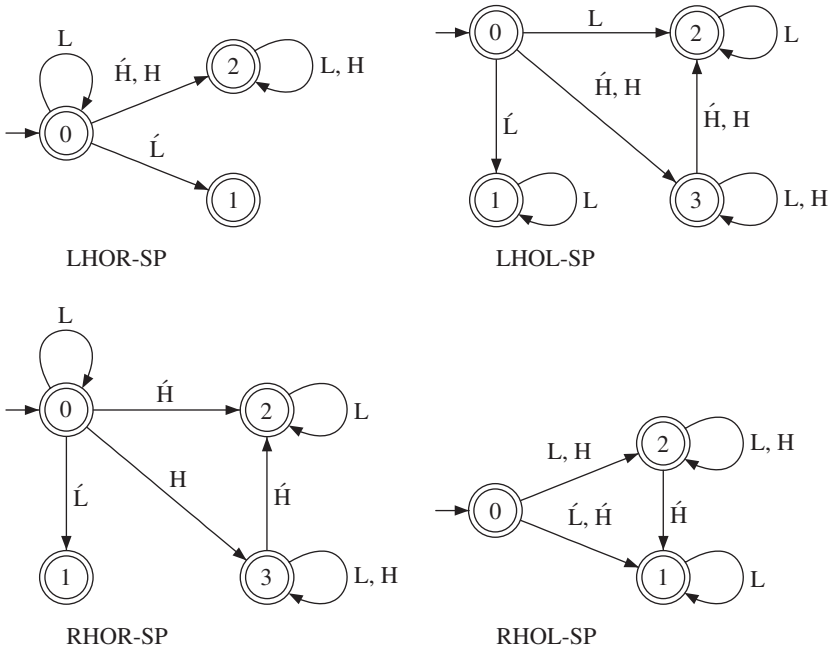


Figure 8.4 Finite-state acceptors accepting the Strictly Piecewise languages given by the permissible and forbidden factors in Table 8.2

patterns, the subsequence LL is permissible. This is because this subsequence occurs in words exemplifying the pattern; e.g. ĹLLL exemplifies the LHOL pattern. But this means that strings of light syllables without *any* stress belong to this formal language! This is because a sequence like LLLLL contains no forbidden subsequence and is therefore, by definition of SP grammars, a perfectly acceptable word. More generally, the Strictly 2-Piecewise languages are unable to express the generalization "At least one primary stress must exist within a word".

Has this enterprise ended in failure? I think not. There is another factor, independently motivated, which is relevant to stress and not to segmental patterns. This factor is *culminativity*, which I take to be the principle that stress patterns have exactly one primary stress in a word.[6] In the remainder of this chapter, I show that once culminativity is factored in, the resulting patterns are exactly the ones given in Figure 8.1. Equivalently, once culminativity is factored out

[6] As mentioned at the outset, some phonologists reserve the term 'culminativity' to mean the principle that every stress pattern 'has at most one primary stress' and use the term 'obligatoriness' to mean the principle that every stress pattern 'has at least one primary stress' (Hyman, 2009).

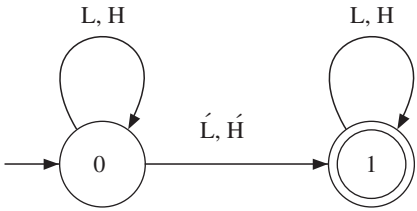


Figure 8.5 A finite-state acceptor describing Culminativity

of the unbounded stress patterns, what is left are exactly languages describable by SP grammars, which therefore are of the same formal character as simple segmental harmony patterns.

8.5 Culminativity

Culminativity is the principle that each word has exactly one prosodic peak. It has long been recognized as a central principle in virtually every theory of stress (Hyman 1977; Halle and Vergnaud 1987; Idsardi 1992; Hayes 1995; van der Hulst *et al.* 2010).

From the perspective of formal language theory, culminativity is the formal language made up of all logically possible words with exactly one primary stress. Figure 8.5 shows the finite-state representation of culminativity. It is not difficult to verify that this acceptor recognizes words like LLLĹ, LLĹL, LĹLL, ĹLLL, HHHH́, HHH́H, HH́HH, H́HHH, and so on. Culminativity is simply that constraint which requires words to have exactly one primary stress; it says nothing about where in the word the primary stress falls.

8.6 Factoring unbounded stress patterns

At this point, all the ingredients necessary for the analysis are present except for one. In section 8.3, finite-state representations were provided which exactly describe the unbounded stress patterns. In section 8.4, the permissible and forbidden subsequences of length two (which are sufficient for describing simple harmony patterns) were given for the unbounded stress patterns. Also in this section it was shown that the languages generated by such grammars do not capture the unbounded stress patterns exactly because they permit words with no primary stress at all. Section 8.4 also provided finite-state representations for the SP versions of the unbounded stress patterns. Finally, section 8.5 provided the finite-state representation of culminativity.

What still needs to be described is some operation that can combine culminativity with the SP versions of each of the unbounded stress patterns to yield the exact infinite sets described by the acceptors in Figure 8.1. This is

because one goal of this chapter is to show that the unbounded stress patterns can be *factored* into Culminativity and the SP versions. In order to complete the argument, it is necessary to show how these two factors together can yield exactly the unbounded stress patterns.

Thankfully, the operation required is simple and was mentioned earlier: set intersection. The words belonging to each of the unbounded stress patterns are exactly those words which are common to *both* the Culminativity pattern *and* the SP versions of the unbounded patterns. In other words, (4) can be written equivalently as (5), where L(G) can be read as 'the language generated by grammar G'.

(5) Specific claims in this chapter (language-theoretic version).
   a. L(LHOR-SP) $\cap$ L(Culminativity) = L(LHOR)
   b. L(LHOL-SP) $\cap$ L(Culminativity) = L(LHOL)
   c. L(RHOL-SP) $\cap$ L(Culminativity) = L(RHOL)
   d. L(RHOR-SP) $\cap$ L(Culminativity) = L(RHOR)

Unlike the case with the intersection of finite sets, it is not immediately obvious how to compute the intersection of infinite sets. However, for *regular* sets, there is a a well-studied operation known as the *acceptor product*. This operation is defined precisely in the 'Appendix'. The product of two acceptors A and B, written A$\times$B, is a third acceptor C. It is known that the language recognized by acceptor C is exactly the intersection of the languages recognized by acceptors A and B. In other words, the claims above can be translated as in (6).

(6) Specific claims in this chapter (acceptor-theoretic version).
   a. LHOR-SP $\times$ Culminativity = LHOR
   b. LHOL-SP $\times$ Culminativity = LHOL
   c. RHOL-SP $\times$ Culminativity = RHOL
   d. RHOR-SP $\times$ Culminativity = RHOR

It is straightforward to verify that each of these claims is correct.[7] For example, the words without any primary stress that are generated by the acceptors in Figure 8.4 are not generated by Culminativity and so they do not survive the intersection process. Likewise, all the words generated by Culminativity which do not exemplify the stress pattern under consideration are also eliminated. The only words which survive the product operation are those which bear exactly one primary stress and which exemplify the stress pattern under consideration.

The main result of this chapter has now been established. Once culminativity is factored out, the unbounded stress patterns are Strictly Piecewise.

[7] Readers can verify this for themselves by using any finite-state manipulation software, such as *xfst* (Beesley and Kartunnen, 2003), or the open-source *foma* (Hulden 2009).

8.7 Discussion

One implication of this result is clear. This analysis unifies long-distance phenomena in both unbounded stress systems and simple segmental harmony systems: they are both Strictly Piecewise modulo Culminativity. This result is important because it suggests the hypothesis that all long-distance phenomena in phonology have an SP characterization as a common denominator. This makes it all the more imperative to examine a broader array of stress patterns and harmony patterns in the context of the subregular hierarchies (Figure 8.2) to see the extent to which this hypothesis is viable.

Another implication of this result is that this analysis reduces the overall complexity of these simple unbounded stress patterns in a concrete way. Recall the classes in Figure 8.2, which classify the complexity of regular sets. By examining the computational complexity of each factor, in addition to the complexity of the whole pattern, one can determine whether the factorization lowers the overall computational complexity.

To illustrate, consider the above analysis. As demonstrated, the SP versions of the simple unbounded stress patterns are Strictly Piecewise. Although not discussed in any detail here, Culminativity belongs to the Locally Threshold Testable region and the simple unbounded stress patterns themselves belong to the NonCounting class.[8] Thus, this factorization lowers the overall complexity of these simple unbounded stress patterns. Factoring Culminativity into 'at most one stress' and 'at least one stress' would lower the complexity even more.[9]

On a technical note, a careful reader may ascertain that it is not necessary to forbid the subsequences {ĹĹ, ĹH́, H́Ĺ, H́H́} in the SP versions of the unbounded stress patterns (Table 8.2). This is because words with more than one primary stress will also be eliminated by the intersection with Culminativity. Let us call this version of the unbounded stress patterns the SP' version.

Nothing in the discussion so far serves to distinguish which of these possibilities, the SP or SP' version, is 'correct'. However, if we consider the problem of learning from surface forms, then an argument can be made in favor of the SP version.

As described in Heinz (2010a, 2010b), Strictly 2-Piecewise languages can be learned. The learner simply observes the subsequences of length two that are present in words it observes and adds them to its list of permissible subsequences (which begins empty).[10] The learner will never observe subsequences like H́H́ and so it will never add those to its list of permissible subsequences; hence, they will always be considered forbidden.

[8] Readers are referred to Rogers and Pullum (2011) for details regarding these classes.
[9] Thanks to Jim Rogers for making this clear to me.
[10] Heinz and Rogers (2010) extend this result stochastically.

Another important implication of the above result is that it simplifies the problem of learning simple unbounded stress patterns. This is because the SP version of the unbounded stress patterns can be learned and because the principle of Culminativity may not need to be since it is arguably a constant principle of Universal Grammar (UG). If it is, then it is always present and available to learners. If it is not, then the problem of learning unbounded stress patterns has been reduced to the problem of learning Culminativity, since the problem of learning SP patterns is solved.

8.8 Conclusion

This chapter has argued for the utility of computational representations in phonological analysis. One reason is that they are at the computational level in Marr's (1982) sense and are therefore relevant to any particular theory of phonology (see also Barton *et al*. 1987: 96–7).

Another reason is that such representations can be used to classify the complexity of known stress patterns according to mathematically principled criteria. The computational classes in Figure 8.2 allow one to identify the nature of phonological patterns – again, independently of any particular grammatical formalism. In fact, the methodology presented in this chapter can be employed to address a much broader question regarding stress patterns: Can the stress patterns be factored in such a way as to reduce their overall complexity?

This chapter focused on a third reason: the fact that insights can be obtained with these representations that would otherwise be difficult to discern. To this end, this chapter showed that unbounded stress patterns can be factored into two parts, each recognizable to phonologists. One part is culminativity, and the other part, like simple segmental harmony systems, can be described exactly in terms of forbidden subsequences of length two. This unification of long-distance phenomena in different phonological domains was made possible by a computational analysis which emphasizes *what* is being computed as opposed to *how* it is computed. It will be interesting to see how far this result can be pushed when more complicated unbounded stress patterns and segmental harmony patterns are considered.

Appendix

This appendix introduces the formalities necessary to establish the results in this chapter.

A8.1 Formal language theory

There is an *alphabet* A, which is fixed and unchanging. In this chapter, the alphabet can be taken to be $A = \{\text{L, H, Ĺ, Ḥ}\}$. The notation A^* is the set of all

logically possible finite sequences of length zero or more constructible from this alphabet. Such sequences are often called *strings*. The concatenation of two strings x and y is written xy. The unique string of length 0 is called the *empty string* and is denoted λ. The length of a string w is denoted $|w|$.

A *formal language* L is a subset of A^*. The concatenation of two languages $L_1L_2 = \{xy : x \in L_1 \text{ and } y \in L_2\}$. Please note that for some language $L \subseteq A^*$ and $a \in A$, sometimes I write La instead of the more technically correct, but cumbersome, $L\{a\}$.

Since many formal languages are infinitely sized sets, they can only be defined in terms of *grammars*. The next three parts of this appendix describe some such grammars.

A8.2 Finite-state acceptors

A finite-state acceptor is a machine with five parts: an alphabet, its states, its initial state, its final states, and its transition function. We write $\mathcal{M} = (A, Q, q_0, F, T)$, where A is the alphabet, Q is the state of states, $q_0 \in Q$ is the initial state, and $F \subseteq Q$ is the set of final states. The transition function is a map $T : Q \times A \to Q$.

Every transition function can be extended to a map $T : Q \times A^* \to Q$ recursively. For all states $q \in Q$ let $T(q, \lambda) = q$. Then for all $x, y \in \Sigma^*$ and $q \in Q$, let $T(q, xy) = T(T(q, x), y)$.

The language generated by a machine $\mathcal{M}$ is defined to be

$$L(\mathcal{M}) = \{w : T(q_0, w) \in F\}$$

In other words, it is all and only those words which the extended transition function maps to final states from the initial state. Any language which can be generated by a finite-state acceptor is said to be *regular*.

The *acceptor product* is defined below. Recall that, for any sets A and B, the *Cartesian product* $A \times B$ is the set of all pairs (a, b) where a is an element of A and b is an element of B. Recall also that, for any sets A and B, the *intersection* $A \cap B$ is the set containing only those elements common to both A and B.

Consider two acceptors with the same alphabet

$$\mathcal{M}_1 = (A, Q_1, q_{01}, F_1, T_1) \text{ and } \mathcal{M}_2 = (A, Q_2, q_{02}, F_2, T_2)$$

Then

$$\mathcal{M}_1 \times \mathcal{M}_2 = (A, Q, q_0, F, T)$$

where

- $Q = Q_1 \times Q_2$;
- $q_0 = (q_{01}, q_{02})$;
- $F = F_1 \times F_2$;

- and for all a $\in A$, $q_1, q'_1 \in Q_1$ and $q_2, q'_2 \in Q_2$, it is the case that $T((q_1, q_2), a) = (q'_1, q'_2)$ if and only if $T_1(q_1, a) = q'_1$ and $T_2(q_2, a) = q'_2$.

An old result is given in the following theorem. A proof can be found in Hopcroft *et al.* (2001).

Theorem 1 $L(\mathcal{M}_1 \times \mathcal{M}_2) = L(\mathcal{M}_1) \cap L(\mathcal{M}_2)$.

This means that a finite-state acceptor generating exactly the intersection of two regular sets can be obtained by finding the acceptor product of the finite-state acceptor for each of those sets.

A8.3 Strictly Local languages

A string u is a *factor* of string w if and only if there exist $x, y \in A^*$ such that $w = xuy$. In this case we write $u \sqsubseteq_f w$. The following function picks out all factors of length k in some string.

$$F_k(w) = \{u : u \sqsubseteq_f w \text{ and } |u| = k\}$$

This function can be applied to sets by extending the function in the usual way:

$$F_k(S) = \bigcup_{w \in S} F_k(w)$$

A Strictly k-Local grammar G is a subset of $F_k(\{\#\}A^*\{\#\})$, where # indicates a word boundary. G is the set of permissible factors. By definition, G is always finite. The language generated by G is:

$$L(G) = \{w : F_k(\#w\#) \subseteq G\}$$

A language is Strictly k-Local if and only if there is some finite grammar G as just defined which generates it exactly. A language is said to be Strictly Local if and only if there exists some k such that it is Strictly k-Local.

A8.4 Strictly Piecewise languages

Informally, a string $u = a_1 a_2 \ldots a_n$ is a subsequence of string w if the letters $a_1, a_2, \ldots a_n$ occur within w in that order. Formally, u is a *subsequence* of w if and only if

$$w \in A^* a_1 A^* a_2 \ldots A^* a_n A^*$$

In this case we write $u \sqsubseteq_s w$. The following function picks out all subsequences up to length k in some string.

$$P_{\leq k}(w) = \{u : u \sqsubseteq_s w \text{ and } |u| \leq k\}$$

This function can be applied to sets by extending it in the usual way.

A Strictly k-Piecewise grammar G is a subset of $P_{\leq k}(A^*)$. G is the set of permissible subsequences. The language generated by the G is

$$L(G) = \{w : P_{\leq k}(w) \subseteq G\}.$$

Equivalently, Strictly k-Piecewise languages can be defined in terms of a finite set of forbidden subsequences; see Rogers *et al.* (2010) for details.

A language is Strictly k-Piecewise if and only if there is some finite grammar G as just defined which generates it exactly. A language is said to be Strictly Piecewise if and only if there exists some k such that it is Strictly k-Piecewise.

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9 Possible and impossible exceptions in Dutch word stress

Carlos Gussenhoven

9.1 Introduction

The stress system of Dutch belongs to the more complex word prosodic systems that have been reported.* As usual, stress is culminative, there being a single most prominent syllable, and obligatory, meaning that all words have a primary stress (Halle and Idsardi 1995; Hyman 2012). As for culminativity, every word has one primary stressed syllable, whose location is right-edge oriented and trochaic. Trisyllabic or longer words will normally have an additional syllable with secondary stress, which may appear before or after the main stress, as in *admiraal* [ˌɑt.mi.ˈraːl] 'admiral', and *marathon* [ˈmaː.ra.ˌtɔn] 'marathon', respectively. Secondary stresses differ from the primary stress in two ways. First, in citation pronunciation, only the primary stress is typically provided with an intonational pitch accent, with another one optionally going to any syllable with secondary stress earlier in the word (e.g. Gussenhoven 2005). Second, in unaccented pronunciations of words with more than one stressed syllable, a syllable with secondary stress is shorter than a syllable with primary stress (Rietveld *et al.* 2004). This means that the contrast between primary and secondary stress is independent of the accentuation of the syllable. For instance, the members of a minimal pair like *kameraadje* [ˌkaː.mə.ˈraː.tjə] 'comrad+DIM' vs. c*ameraatje* [ˈkaː.mə.ˌraː.tjə] 'camera+DIM', due to Vincent van Heuven, thus remain clearly distinct in the compounds *filmkameraadje* 'movie friend' and *filmcameraatje* 'movie camera', where the only pitch accent is on *film*.

Dutch is Quantity Sensitive for the purposes of primary stress assignment, with closed syllables, diphthongs, and lexically long vowels attracting the stress. Stress assignment before the primary stress is not Quantity Sensitive (van der Hulst & Kooij 1995). In effect, it is only the segmental composition

* I am grateful to three reviewers for raising numerous questions about the analysis. I have not always been able to deal with them to my full satisfaction, but have almost always responded to them in the text. I thank Otto Gussenhoven and Anneke Neijt for discussing the status of some words as exceptional and for suggesting further examples.

of the rimes of the last two syllables of the word that are relevant to stress assignment.

The 'generative' metrical literature on Dutch stress began with van der Hulst (1984). A circumstance that has caused considerable confusion is that, in addition to the domain-specific Quantity Sensitivity, the quantity of non-high tense vowels is determined by whether the syllable has (primary or secondary) stress. The difference between the short allophones of these vowels, which appear in unstressed syllables, and the long allophones, which appear in stressed vowels, has been widely ignored, and all occurrences have been classed as 'long'. As a result, a non-high tense vowel may seem to be inactive for the purposes of Quantity Sensitivity in positions where closed syllables are not. For instance, while the closed penultimate syllable in *Alaska* will attract main stress ([a.ˈlɑs.ka]), a word like *almanak* will not. The point is that the tense vowel in the penultimate position of words like *almanak* has traditionally been assumed to be long, i.e. *[ˈɑl.ma:.ˌnɑk], while in reality it is short, [ˈɑl.ma.ˌnɑk]. The long quantity of these vowels only shows up in stressed syllables and in closed syllables, and in both cases is derivable from an underlying moraically unspecified vowel. The representation of these vowels as underlyingly long has led to the incorrect claim that Dutch is typologically deviant, because 'long' vowels seemingly act as if they were light (van Oostendorp 1997; Gussenhoven 2009). However, if they become heavy only after stress has been assigned to them, this deviant typological feature of Dutch disappears.

In the sense that free lexical marking allows the exceptional stress to be characterized with the help of the regular stress grammar of the language, exceptional stress positions are 'in tune' with the regular stress patterns. Like regular stress, they all fall within a right-edge trisyllabic window. In other languages, exceptional stress may occur on the side of the word opposite to that of the regular stress positions. As a reviewer pointed out, this is true for 7 of the 511 languages listed in StressTyp (2006). The way exceptions are to be described for Dutch, therefore, will not be generally applicable. Other languages may need co-phonologies to account for exceptions. This chapter does claim that lexical marking is the correct way of accounting for exceptions in Dutch, *contra* Zonneveld and Nouveau (2004), who argue that a number of co-phonologies are active in the Dutch stress grammar.

9.2 The interaction between stress and quantity

In order to appreciate the interaction between the segmental structure and the foot structure, Table 9.1 presents the vowel system of Standard Dutch as it is observed in stressed syllables (Gussenhoven 1992; Booij 1999). The first column gives the five short lax vowels, the second the seven tense vowels. The high members of this group are short, unless appearing before [r] in the

Table 9.1 *The vowels of Dutch that can appear in stressed syllables*

Short lax	Tense	Long	Complex
ɪ y	i y u	iː yː uː	ɛi œy ʌu
ɛ ɔ	eː øː oː	ɛː œː ɔː	
ɑ	aː	ɑː	

Table 9.2 *The vowels of Dutch that can appear in word-peripheral unstressed syllables*

Short lax	Tense	Long	Complex	Schwa
ɪ ʏ	i y u		ɛi œy ʌu	ə
ɛ ɔ	e ø o			
ɑ	a			

same foot. In Gussenhoven (2009), I give a full account of this variation; for this chapter, that issue is not relevant. The third column gives the vowels that Moulton (1962) characterized as 'marginal' on the grounds of their exclusive occurrence in recent loanwords and onomatopoeia. In the fourth column, the three diphthongs are given. Table 9.2 shows the vowel system that appears in unstressed positions. The first generalization is that unstressed syllables only contain short vowels, including short versions of otherwise long vowels (see the second column; Rietveld *et al.* 2004; Gussenhoven 2009). This means that the 'marginal' long vowels cannot occur there: *[hɔːr.ˈloː.ʒə], [hɔr.ˈloː.ʒə] *horloge* 'watch'.[1] The second generalization is that schwa only appears in unstressed syllables.

The constraints that will create this distribution are listed below. The Stress-to-Weight Principle (SWP), given in (1) (Kager 1999: 168, and his references to Myers 1987 and Riad 1992; Gouskova 2003), requires that a stressed syllable be bimoraic, causing tense vowels to be long in stressed open syllables, while the default situation is described by constraint (2), SYLMON, according to which syllables are monomoraic. Any additional mora incurs a violation.

(1) Stress-to-Weight Principle (SWP): Foot heads are (minimally) bimoraic.

(2) SYLMON: Syllables are monomoraic.

[1] Long vowels occur in unstressed word-final syllables that are closed. Their bimoraic status derives from a requirement to fill the moraic structure (one for the vowel and one contributed by the consonant) with vocalic segments. This constraint, SONPEAK, will be dealt with in section 9.3.

9.3 Regular stress

Regular primary stress is illustrated in (3) and (4). All of these cases are discussed in Trommelen and Zonneveld (1999) and Gussenhoven (2009), with the exception of case (4e). Primary stress is penultimate, as shown in (3), unless:

(i) the word is monosyllabic, in which case it has primary stress, as shown in (4a);
(ii) the final rime is superheavy, i.e. contains a long vowel or diphthong plus coda consonant or a short vowel plus two coda consonants, in which case it has primary stress, as shown in (4b);
(iii) the final syllable is closed, the penultimate is open and there is an antepenultimate syllable available, in which case the antepenultimate syllable has primary stress (4c, d);
(iv) the final syllable is an onsetless schwa after a high vowel (4e).

(3)
a. a.ˈχaː.ta *Agatha*
b. a.ˈmɑn.da *Amanda*
c. ˈaː.lɛks *Alec*
d. pa.ˈlɛm.bɑŋ *Palembang*

(4)
a. ˈlaː *la* ‘drawer’
b. ˌɑt.mi.ˈraːl *admiraal* ‘admiral’
c. ˈmaː.ra.ˌtɔn *marathon* ‘marathon’
d. a.ˈkrɔs.ti.ˌχɔn *akrostichon* ‘acrostic’
e. ˈbɛl.χi.ə *België* ‘Belgium’

Summarizing (Gussenhoven 2009 and references therein), the regular cases are described by RHYTHMTROCHEE (5), which requires feet to be left-dominant. The Weight–to–Stress Principle (WSP), given in (7), is needed to ensure that bimoraic syllables are foot heads. As will be shown below (tableau (14)), this constraint will create the effect seen in (4c) of moving the main stress to antepenultimate position when the final syllable is closed. That is, because the final closed syllable is stressed and cannot be in the weak position of a trochee, a bisyllabic trochee gets to be located one syllable further to the left. WSP can be collapsed with SWP in this grammar. Of the two stressed syllables (the final syllable and the antepenult), the antepenult will have main stress. This is due to the constraint requiring the main stress to be rightmost (F’RIGHT, given in (8)), together with higher-ranking NONFIN (9), which militates against final main stress. One of the tasks of F’RIGHT is to prevent main stress from appearing outside a right-edge three-syllable window, which (4d) is meant to remind us of. FOOTBINARITY ensures that feet are not longer than disyllabic or shorter than bimoraic (6). (In section 9.5, we will see that this constraint is bested by

a constraint banning hiatus before schwa.) Finally, items (3a, b, d) and (4d) show that single word-initial syllables do not form monosyllabic feet. This is achieved by NoClash (10).

(5) RhythmTrochee: Feet are left-dominant.

(6) FootBinarity (FootBin): Feet are disyllabic or bimoraic.

(7) WSP: Bimoraic syllables are stressed.

(8) F'Right: The right edge of the word coincides with the right edge of a strong foot.

(9) NonFinality (NonFin): Main stress is not on the word-final syllable.

(10) NoClash: Foot heads are not adjacent.

In tableaux (11)–(17), the assumption of undominated RhythmTrochee and FootBinarity is made. In tableaux (11) and (12), we see that (3a) and (3b), which have a light final syllable, are identified correctly, assuming unranked NoClash, NonFinality, and F'Right, while tableaux (13) shows that WSP does not destroy the regularity of penultimate stress in a disyllable like (3c), if WSP is ranked below NoClash and NonFinality. We will deal with exceptions in section 9.5, but mention examples of exceptions to (11): [ˈkaː.na.ˌdaː] *Canada* 'Canada' and [ˌʃoː.ko.ˈlaː] *chocola* 'chocolate'; an exception to (12) is [ˈɪs.stɑm.ˌbul] *Istanbul* 'Istanbul', and an exception to (13) is [i.ˈrɑn] *Iran* 'Iran'.

(11)

aχata	NoClash	NonFin	WSP/SWP	F'Right
☞a. a.ˈ(χaː.ta)				
b. (aː).ˈ(χaː.ta)	*!			
c. ˈ(aː.χa).ta				*!
d. ˈ(aː.χa).(taː)				*!
e. (aː.χa)ˈ(taː)		*!		
f. a.ˈ(χa.ta)			*!	

(12)

amanda	NoClash	NonFin	WSP/SWP	F'Right
☞a. a.ˈ(mɑn.da)				
b. (aː).ˈ(mɑn.da)	*!			
c. (aː.mɑn).ˈ(daː)		*!	*!	
d. ˈ(aː.mɑn).(daː)			*!	*!
e. ˈ(aː.mɑn).da			*!	*!
f. a.ˈ(mɑn).da				*!

(13)

alɛk	NoClash	NonFin	WSP/SWP	F'Right
☞a. ˈ(aː.lɛk)			*	
b. a.ˈ(lɛk)		*!		
c. ˈ(aː).(lɛk)	*!			*
d. (aː).ˈ(lɛk)	*!	*!		

Turning to trisyllabic or longer words with closed final syllables, we compare (3d), which has a closed penultimate syllable, with (4c, d), where the penultimate syllable is open. The weight difference in the penultimate syllable causes underlying /maratɔn/ to have antepenultimate main stress, since this candidate is the only one that satisfies all three of the constraints NoClash, NonFin, and WSP/SWP. This is shown in tableau (14). However, in the case of /palɛmbɑŋ/, violations of WSP/SWP are unavoidable. Now it is F'Right that gets to decide between *[ˈ(paː.lɛm).(bɑŋ)] and [pa.ˈ(lɛm.bɑŋ)]; it picks out the latter as the winner. An exception to (14) is [hɔnˈ(dyːrɑs)] *Honduras* 'Honduras', and to (15) [ˈ(kaː.zɑχ)(stɑn)]. As will be clear, trochees can end up as H, HL, and HH (where H is 'heavy' and L is 'light'; below we will see that H can also be 'superheavy').

(14)

maratɔn	NoClash	NonFin	WSP/SWP	F'Right
☞a. ˈ(maː.ra).(tɔn)				*
b. (maː.ra).ˈ(tɔn)		!*		
c. (maː).ˈ(raː.tɔn)	*!		*	
d. ma.ˈ(raː.tɔn)			*!	
e. ˈ(maː.ra).tɔn			*!	*

(15)

palɛmbɑŋ	NoClash	NonFin	WSP/SWP	F'Right
a. ˈ(paː.lɛm).(bɑŋ)			*	*!
b. (paː.lɛm).ˈ(bɑŋ)		*!	*	
c. (paː).ˈ(lɛm.bɑŋ)	!*		*	
☞ d. pa.ˈ(lɛm.bɑŋ)			*	
e. ˈ(paː.lɛm).bɑŋ			**!	

As for (4a), a constraint requiring a major class word to have main stress will ensure that all words, including monosyllables, will have main stress, and ranking the Superheavy-to-Stress Principle (SHSP, shown in (16)) above NonFin will allow [(ɑt.mi).(ˈraːl)] to have final main stress, as shown in (17). Disyllables with superheavy rimes will similarly have final main stress, leaving the first syllable unfooted, as in the case of [viːˈlɛin] *vilein* 'virulous'. An exception to (17) is [ˈ(oː.jə).(vaːr)] *ooievaar* 'stork', while by the side of *vilein* there is, for instance, [ˈ(klɛi.noːt)] *kleinood* 'precious item'.

(16) Superheavy-to-Stress Principle (SHSP): Trimoraic syllables have main stress.

(17)

kapitɛin	NoClash	SHSP	NonFin	WSP/SWP	F'Right
☞a. (kaː.pi).ˈ(tɛin)			*		
b. ˈ(kaː.pi).(tɛin)		*!			*
c. ka.ˈ(pi.tɛin)		*!		**	

The final type of regular case, that of (4e), requires a constraint that forbids hiatus within the foot. It was noted in Kager and Zonneveld (1986) that underived trisyllabic feet occur in words whose last syllable is an onsetless schwa, as in [ˈbɛl.χi.ə] *België* 'Belgium', [ˈʋeː.dy.ə] *weduwe* 'widow'. Strikingly, there are no words of this structure that have main stress on the penult in trisyllabic words. (Even bisyllables with high vowels abutting schwa are rare, like [ˈni.ə] *Niehe* [proper name]). In (18), Hiatus is given as a specific constraint for this case. In (20), three candidates are compared. Forms like (20c), which have an unparsed final schwa, are bad by AllFeetRight (19). Hiatus must outrank FootBin (6) in order to force antepenultimate stress. The status of the (irrelevant) violation of WSP by candidate (b) will be considered in section 9.4.3.

(18) Hiatus: Don't have hiatus after a penultimate [+high] foot head before schwa in a trisyllabic word.

(19) AllFeetRight (AllFtRt): All feet are located rightmost in the word.

(20)

bɛlχiə	Hiatus	AllFtRt	FootBin	NoCl	SHSP	NonFin	WSP/SWP	F'Rt
☞a. ˈ(bɛl.χi.ə)			*					
b. bɛl.ˈ(χi.ə)	*!						*	
c. ˈ(bɛl.χi).ə		*!						

9.4 More on segmental structure: ambisyllabic consonants, exceptionally long vowels, and monomoraic closed syllables

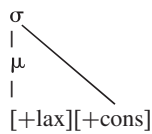
Before we move on to the exceptions, we need to take account of three further regularities between segmental and moraic structures. First, short lax vowels only occur in closed syllables. Second, lax vowels may be exceptionally long. Third, word-initial unstressed syllables are monomoraic.

9.4.1 Ambisyllabic consonants

Like other West Germanic languages, Dutch has ambisyllabic consonants. While English ambisyllabic consonants result from post-lexical, largely

stress-induced processes,[2] Dutch ambisyllabic consonants exist in fulfillment of a constraint requiring short lax vowels to be followed by a coda consonant (van der Hulst 1985). It is given in (21). If the lax vowel is associated with two moras, i.e. underlyingly long, as in [krɛːm] *crème* 'cream', there is no requirement for the presence of a coda consonant. Like the lax vowel, the [+cons] in (21) will always be moraic, but it will have an additional association to the next syllable if it is ambisyllabic. An ambisyllabic consonant will be notated twice in transcriptions, separated by a full stop to indicate the syllable boundary (e.g. *Anna* [ˈɑn.na]).

(21) LAX + C:



Constraint (21) makes it possible for stressed syllables to have short vowels, as long as these are lax. The consonant following [ɪ, ʏ, ɛ, ɔ, ɑ] will be a coda consonant, as is [n] in [sɑn.ˈdaːl] *sandaal* 'sandal', even if it is the only consonant separating the short lax vowel from the next vowel. In that case, the consonant is ambisyllabic, as in [ɑn.ˈnaː.lə] *annalen* 'annals', [ˈɑn.na] *Anna* (proper name). These examples show that both stressed and unstressed syllables are subject to the constraint. Together with ONSET (22), LAX+C will create ambisyllabic consonants, as shown in (23). The lack of a coda in (23b, c) violates LAX+C. Candidate (23e) introduces a mora for no reason. I excluded it by means of LAX+C in Gussenhoven (2009), as I do here, but, as a reviewer pointed out, this must be seen as a stand-in for a violation of a higher-ranked DEP(μ).

(22) ONSET: A syllable has an onset.

(23)

ɑna	ONSET	WSP/SWP	LAX+C	SYLMON
☞a. (ˈɑn.na)	*			*
b. (ˈɑ.na)	*	*!	*	
c. (ˈɑː.na)	*		*!	*
d. (ˈɑn.a)	**!			
e. (ˈɑːn.na)	*		*!	**

As shown by van der Hulst (1985), the validity of LAX+C appears from a number of distributional facts. One of these is that before hiatus only tense vowels can appear, as shown by [hi.ˈaːt] *hiaat* 'hiatus' *[hɪ.ˈaːt], [kre.ˈoːl] *creool* 'creole' *[krɛ.ˈoːl], [χa.ˈoːt] *chaoot* 'chaotic person' [χɑ.ˈoːt]. Another is

[2] See Hall (2006), which gives references to ambisyllabic treatments as well as to work objecting to the concept of ambisyllabicity on theoretical grounds.

that [j,w], which do not appear in the coda after lax vowels, resist ambisyllabification, as shown by [ˈkaː.jɑk] *kayak* 'kayak' *[ˈkɑj.jɑk], [piˈjaːma] *pyjama* 'pyjamas' *[pɪj.ˈjaːma].[3]

9.4.2 *Exceptionally long vowels*

Long vowels have two sources. They either come as long vowels from the lexicon or they are long because they are stressed or need to satisfy SonPeak, to be introduced below. The first group includes long lax vowels, the 'marginal' vowels of Dutch (Moulton 1962). Examples are [kɑːst] *cast* 'cast', cf. [kaːst] *kaast* 'make cheese+3sg', [kɑst] *kast* 'cupboard'; [blɛːr] *blèr* 'shout', cf. [hɛr] *her* 'resit/retake', [heːr] *heer* 'gentleman'; [kɔːr] *corps* 'fraternity, cf. [koːr] *koor* 'choir', [kɔr] *kor* 'trawl'. Because of their bimoricity, they are stressed, thanks to WSP, provided FaithMora, shown in (24), is ranked above Lax+C and SylMon. High tense vowels, too, may be marked as long in the lexicon, as indicated in Table 9.1. The effect of FaithMora is shown for *cast* in (25).

(24) FaithMora: Preserve the mora structure.

(25)

kɑːst	Onset	WSP/SWP	FaithMora	Lax+C	SylMon
☞a. (kɑːst)				*	*
b. (kɑst)			*!		

In order to prevent rhymes with tense vowels from satisfying SWP by using a consonant for the second mora, SonPeak (26) is needed to force the vowel to lengthen. This is shown in (28) for [kaːs] *kaas* 'cheese' (cf. kɑt *kat* 'cat' in (27)). It is part of the constraint family maximizing sonority in the syllable rhyme (cf. Hnuc; Prince and Smolensky 1993: 134). Violations are given only for the first two moras in a rime.

(26) SonPeak: μ
|
[–cons]

[3] van der Hulst (1985) explained the second generalization on the grounds that coda [w,j] would illegitimately create new diphthongs, *[ɑj], etc. However, this is not a valid objection, because the three Dutch diphthongs are purely vocalic. The glide that appears after diphthongs and mid tense vowels is not equivalent to the phonemic [j,w], as shown by the fact that [ˈry.wə] *ruwe* fails to rhyme with [ˈkry.ə] *cruë* 'coarse, inconsiderate+infl' (Gussenhoven 1980; for an overview of the difference with tense vowel + glide combinations, see Zonneveld and Trommelen 1980). Second, marginal *lax* vowel + glide combinations do appear in recent loans, like [deˈtɑj] *detail* 'detail', [mɑjs] *maïs* 'maize', [rɔj] *Roy* (proper name).

(27)

kɑt	ONSET	WSP/SWP	LAX+C	SONPEAK	SYLMON
☞ a. ˈ(kɑt)				*	*
b. ˈ(kɑːt)			*!		**

(28)

kas					
☞ a. ˈ(kaːs)					**
b. ˈ(kas)				*!	*

One of the reasons why Trommelen and Zonneveld (1999: 500) rejected an analysis whereby tense vowels are underlyingly short or unspecified for quantity was that they are long even if occurring in a closed syllable. As we have seen, constraint SONPEAK can be used to solve this issue. In section 9.5 it will be shown that unstressed tense vowels in closed syllables are long, as in [ˈklɛi.noːt] *kleinood* ‘precious item’.

9.4.3 Word-initial unstressed syllables

As we have seen, the segmental composition of the final and penultimate syllables crucially determine whether main stress is antepenultimate or penultimate. The segmental composition of the antepenultimate syllable is effectively immaterial. Still, the analysis predicts that if we were to allow syllables to the left of the main stress to be weight-sensitive, correct assignments of main stress would be frustrated because of WSP violations. Incorrect antepenultimate stress would result in words with heavy antepenultimate syllables, like [ɑŋ.ˈχoː.ra] *angora* ‘angora’, [sɔm.ˈbreː.ro] *sombrero* ‘sombrero’, [ɑr.ˈmaː.da] *armada* ‘armada’, [pɑn.ˈdoː.ra] *Pandora* (proper name), and [sɪr.ˈtaː.ki] *Sirtaki* (Greek dance).[4] To see this, consider tableau (29), in which candidate (29d) wins. On the assumption that closed syllables are heavy everywhere, candidate (29c) fails to satisfy WSP and is eliminated. Satisfying WSP by parsing the initial syllable as a foot is no help, because of NOCLASH. In revised tableau (29ˈ), it is assumed that word-initial pre-stress syllables are unstressed and monomoraic, remaining unfooted as a result. Now candidate (29ˈc) no longer violates WSP, and beats candidate (29d) by satisfying F’RIGHT. The analysis of Dutch word-initial pre-stress syllables as unfooted and monomoraic was proposed in Gussenhoven (1993) independently of the facts in tableaux (29) and (29′). A restricted Weight-by-Position constraint is used in Gussenhoven (2009) to prevent the first syllable of *armada* from being bimoraic (‘From the main stress onward, a coda consonant projects a mora’).

[4] With regard to the use of the symbol for the voiceless uvular fricative, the transcriptions used are as for standard Netherlandic Dutch. For Belgian Dutch, see Verhoeven (2005).

(29)

ɑrmada	NoClash	NonFin	WSP/SWP	F'Right
a. (ɑr).ˈ(ma:.da)	*!			
b. (ɑr.ma).ˈ(da:)		*!		
μμ | | c. ɑr.ˈ(ma:.da)			*!	
☹ d. ˈ(ɑr.ma)(da:)				*

(29ˈ)

ɑrmada	NoClash	NonFin	WSP/SWP	F'Right
a. (ɑr).ˈ(ma:.da)	*!			
b. (ɑr.ma).ˈ(da:)		*!		
μ ⋀ ☞c. ɑr.ˈ(ma:.da)				
d. ˈ(ɑr.ma)(da:)				!*

The stress grammar of Dutch, basically NoClash, SHSP, NonFin > WSP/SWP > F'Right, characterizes regular main stress in a language whose stress system is notorious for its lack of transparency. This lack of transparency is caused, first, by the regular antepenultimate case of [ˈma:.ra.ˌtɔn], which spoils any initial generalization of penultimate stress, while the second confusing circumstance is that Dutch is both Quantity Sensitive (i.e. obeys WSP) and requires stressed rhymes to be minimally bimoraic (SWP).[5] Failure to recognize that tense vowels are underlyingly mora-less led to unsupportable claims that Dutch breaks the generalization that if VC is heavy, so will be VV, as pointed out in section 9.1 (cf. Hayes 1995).

9.5 Exceptional stress patterns

The purpose of this section is to show that freely marking Dutch words in the lexicon with word-stressed or plain foot heads will lead to six types of exceptional stress, all of which are attested. Four types of potentially exceptional stress are not attested. Because the term 'ungrammatical' may be ambiguous between 'irregular, but attested' and 'irregular and unattested', these unattested stress patterns will be referred to as 'impossible' stress patterns. Two of these are ruled out by our free marking hypothesis. It will be argued that the third violates a constraint requiring feet to end with a 'crisp edge', and the fourth the constraint ruling out hiatus before schwa, Hiatus, given in (18).

Three of the six attested exceptional types, given in (30), are dealt with straightforwardly by specifying a syllable as a foot head in the lexical

[5] SWP is also referred to as Prokosch's Law (van Oostendorp 1995, following Riad 1992). Prokosch (1939: 125, 140) associated long stressed vowels with vowels in open syllables, but his generalization has come to be applied to stressed vowels or rhymes generally.

representation. I notate foot heads by an opening bracket. This is in agreement with Idsardi (2009), who postulates that either a left or a right partition juncture be used, but not both. However, as pointed out by a reviewer, Idsardi's theory would restrict the lexical marking to foot heads, whereas for the Dutch data I need to be able to mark main stress as well, as in the case of *chocola* and *olifant* (tableaux (36) and (37)).

In order for these lexical markings to have any effect, FaithFoot, given in (31), must be ranked above SHSP, NonFin, WSP/SWP, and F'Right. Although he didn't work out his proposal, the suggestion that exceptions in Dutch should be handled in this way was earlier made by van Oostendorp (1997).

(30)

a. ˈkaːnaˌdaː	*Canada*	'Canada'	(cf. [aˈχaːta])
b. kaˈnɔn	*canon*	'cannon'	(cf. [ˈaːlɛk])
c. hɔnˈdyːrɑs	*Honduras*	'Honduras'	(cf. [ˈmaːraˌtɔn])

(31) FaithFoot: Do not delete foot structure.

The derivation of (30a) is shown in tableau (32). By requiring the last syllable to be a foot, FaithFoot disables regular candidate (32c), leaving it to NonFin to select the dactylic pattern of *marathon*. Apart from an irrelevant violation of WSP by the equivalent candidate (30c), the treatment of *Canada* is no different from that of words like [ˈχɔndoˌlaː] *gondola* 'gondola' (cf. regular [ɑrˈmaːda]), which have a closed initial syllable. Tableau (33) shows the case of the disyllabic (30b), where the lexical final foot acquires main stress, there being no antepenultimate syllable.

Case (30c), representative of trisyllabic words with a heavy or superheavy final and an open penultimate syllable, typically represented by geographical or language names like *Celebes*, *Karawang*, *Tagalog*, has a penultimate foot head in the lexicon, as shown in tableau (34). It leads to penultimate stress, as would happen regularly if the final syllable was open.

(32)

kana(da	NoClash	FaithFoot	SHSP	NonFin	WSP/SWP	F'Right
☞ a. ˈ(kaː.na).(daː)						*
b. (kaː.na).ˈ(daː)				* !		
c. kaˈ(naː.da)		*!				

(33)

ka(nɔn	NoClash	FaithFoot	SHSP	NonFin	WSP/SWP	F'Right
☞ a. ka.ˈ(nɔn)				*		
b. ˈ(kaː.nɔn)		*!			*	
c. ˈ(kaː).(nɔn)	*!					*

(34)

hɔn(dyrɑs	NoClash	FaithFoot	SHSP	NonFin	WSP/SWP	F'Right
☞ a. hɔn.ˈ(dyː.rɑs)					**	
b. (hɔn).ˈ(dyː.rɑs)	*!				*	
c. ˈ(hɔn.dy).(rɑs)		*!				*!

Unexpected main stress on the final syllable of trisyllabic (or longer) words is attested in (35a), while unexpected main stress on the first syllable of trisyllabic words with heavy or superheavy final syllables is attested by (35b). These words require a lexical marking of main stress. Instead of just a final foot, words like *chocola* will need to have a main stress on the last syllable, which leads to final stress, as shown in (36). It shows that FAITHFOOT throws out candidates (b), which preserves the final foot but fails to preserve main stress, and (c), which fails to preserve the final foot and, by implication, final main stress. Case (35a) also covers words like [ˌkaː.lə.ˈbɑs] *kalebas* 'gourd', [ˌmɑχ.nə.ˈtrɔn] *magnetron* 'microwave oven' (cf. [ˈmaː.ra.ˌtɔn]), which incur an irrelevant violation of WSP in the equivalent pronunciations of candidate (36c).

(35) a. ˌʃoː.ko.ˈlaː *chocola* 'chocolate' (cf. [a.ˈχaː.ta])
b. ˈoː.li.ˌfɑnt *olifant* 'elephant' (cf. [ˌɑt.mi.ˈraːl])

(36)

ʃokoˈ(la	NOCLASH	FAITHFOOT	SHSP	NONFIN	WSP/SWP	F'RIGHT
☞ a. (ʃoː.ko).ˈ(laː)				*		
b. ˈ(ʃoː.ko).(laː)		* !				*
c. ʃo.ˈ(koː.la)		* !*				

While main stress must be lexically marked finally in (35a), a pre-final foot with main stress is needed to derive cases like (35b).[6] Despite a different pattern of irrelevant violations, the treatment is not essentially different from that shown in tableau (36): plausible but incorrect candidates (37b, d) fail to satisfy FAITHFOOT, while (37c) fatally violates NOCLASH, leaving (37a) as the winner. A closed penultimate syllable makes little difference. Words like [ˈɪs.stam.ˌbul] *Istanbul* 'Istanbul' and [ˈhɛl.sɪŋ.ˌki] will see the equivalents of (37b, c, d) eliminated by NOCLASH and FAITHFOOT in the same way.[7]

(37)

ˈ(olifɑnt	NOCLASH	FAITHFOOT	SHSP	NONFIN	WSP/SWP	F'RIGHT
☞ a. ˈ(oː.li).(fɑnt)			*			*
b. (oː.li).ˈ(fɑnt)		* !		*		
c. ˈ(oː).(li.fɑnt)	* !		*		*	*
d. o.ˈ(li.fɑnt)		* !*	*		*	

The final attested exception to regular stress is exemplified by (38). In the usual interpretation, F'RIGHT requires the foot with main stress to be aligned rightmost in the word (Kager 1999: 167). In tableau (39), the violation by candidate (39e) of F'RIGHT is incurred because the right edge of the word is

6 This pattern would appear to be restricted to placenames (*Zevenaar*) and words denoting animals. In addition to *olifant*, there are *adelaar* 'eagle', *lepelaar* 'spoonbill', *ooievaar* 'stork', *wielewaal* 'oriole'.

7 *Helsinki* has a monomoraic final foot, which is required by a constraint making high tense vowels short. It outranks any constraint requiring stressed syllables to be long. For this analysis and the relevant tableau, see Gussenhoven (2009).

not aligned with the foot that has main stress. Candidate (39d) fails to obey SonPeak. The other candidates founder on NoClash or FaithFoot.

(38) ˈklɛi.noːt *kleinood* 'precious item' (cf. [viˈlɛin])

(39)

(klɛinot	NoClash	FaithFoot	SonPeak	SHSP	NonFin	WSP/SWP	F'Right
a. ˈ(klɛi).(noːt)	* !			*			*
b. (klɛi).ˈ(noːt)	* !				*		
☞ c. ˈ(klɛi.noːt)				*		*	
d. ˈ(klɛi.not)			*!			*	
e. ˈ(klɛi).noːt				*		*	*!
f. klɛi.ˈ(noːt)		*!			*	*	

This section has argued that all the attested exceptions can be derived from our grammar if we adopt a free marking policy of heads of feet, with or without main stress. We have not needed to adopt any additional structure, like compounding for the forms in (35b) and (38); for such evidence from a compound analysis, see Gussenhoven (2009), and for evidence against from language acquisition, see Fikkert (2001: 64). It remains to be shown that impossible patterns cannot be produced by free marking of foot heads. The next section is devoted to this topic.

9.6 Impossible stress patterns

There are four impossible patterns, listed in (40). Cases (40a) and (40b) are well-known cases of impossible patterns; case (40c) was noted by Kager and Zonneveld (1986), while case (40d) is here introduced for the first time.[8]

(40)
a. *ˈheː.li.ˌkɔp.tər (cf. [ˌheː.li.ˈkɔp.tər] *helikopter* 'helicopter')
b. *ˈbaːˌlaː.də (cf. [ba.ˈlaː.də] *ballade* 'ballad')
c. *bɛl.ˈχi.ə (cf. [ˈbɛl.χi.ə] *België* 'Belgium')
d. *ˈspaːχɛtˌti (cf. [spaˈχɛt.ti] *spaghetti* 'spaghetti')

Case (40a) breaks the right-edge three-syllable window for Dutch stress. Without further assumptions, our account appears to make the wrong prediction by selecting a candidate with two instances of main stress, as shown in tableau (41) (see candidate (41a)), at the expense of the correct candidate (41b). It is, however, not hard to argue that candidate (41a) is a plausible lexical output, whereby the promotion of the rightmost main stress is taken care of by a post-lexical rule. In fact, a pronunciation whereby both primary stresses are pronounced as pitch-accented syllables is a well-formed, if somewhat emphatic, pronunciation of the word.

[8] I discussed case (40d) in a presentation given at the Conference on the Phonological Word in Berlin (ZAS), October 24–26, 1997 ('Duration and Quantity in the Dutch Word').

(41)

ˈ(helikɔptər	NoClash	FaithFoot	SHSP	NonFin	WSP/SWP	F'Right
☞a.ˈ(heː.li).ˈ(kɔp.tər)						
b.ˈ(heː.li).(kɔp.tər)						*!
c. (heː.li).ˈ(kɔp.tər)		*!				

Case (40b) illustrates the ungrammatical lack of main stress in syllables before schwa. To rule out this impossible form, high-ranking AllFeetRight (19), which militates against unfooted syllables at the right edge, is to be called upon.[9] Tableau (42) shows its effect: candidate (42c), which preserves the lexical foot, violates AllFeetRight by leaving the last syllable unfooted. Candidate (42d), [ˈ(baː.la).(də)], founders on FootBin in the tableau, but will in reality already have been excluded by RhythmTrochee, unless that constraint were incongruously to be formulated without regard to moricity. The reason for the regularity that schwa requires main stress immediately before it in this analysis is that the syllable containing it cannot be a foot head, in combination with the impossibility of having adjacent foot heads. The fact that schwa in (42) is word-final is not the issue, as shown by the equally impossible pattern of *[ˈkaː.rɑk.tər] (cf. [ka.ˈrɑk.tər] *karakter* 'character' as well as the possible exception of [ˈ(bɛt.mɪn).(tɔn)] *badminton* 'badminton', discussed below). In this analysis, schwa is phonologically visible, like all other segments.

(42)

(baladə	AllFtRt	NoClash	FootBin	FaithFoot	NonFin	WSP/SWP	F'Rt
a. ˈ(baː.la.də)			*!				
b. ˈ(baː).(laː.də)		*!					*
c. ˈ(baː.la).də	!*						
d. ˈ(baː.la).(də)			*!				
☞e. ba.ˈ(laː.də)				*			

Next, the fact that (40c) is categorically disallowed follows from the high ranking of hiatus, introduced in (18), which forbids an onsetless schwa after main stressed high vowel. Its ranking makes forms like (40c) unnegotiable.[10] Finally, I turn to (40d). A classic observation in treatments of Dutch stress is that penultimate syllables with short lax vowels are treated like closed syllables

[9] The constraint is needed irrespective of how F'Right is interpreted. In the usual interpretation, F'Right partly subsumes Parseσ, which militates against unfooted syllables, and AllFeetRight, according to which feet must be located rightmost in the word. In the alternative, 'conditional' interpretation, F'Right requires the rightmost foot in the word to have main stress, regardless of whether that foot aligns rightmost in the word (Al-Jarrah 2008).

[10] After a non-high vowel, penultimate stress would appear to be regular, as in [myˈzeː.əm] *museum* 'museum'. When a vowel other than schwa forms the final syllable, both penultimate and antepenultimate main stress occur, as illustrated by [ˈaː.ri.a] *aria* 'aria', [ˈaː.lo.eː] *aloë* 'aloe vera', [ˈfaː.ra.oː] *farao* 'pharaoh', [ˈpaː.pu.aː] *Papoea* 'Papua', [ˈxeː.ny.aː] *Genua* 'Genoa', [ˈraː.di.oː] *radio* 'radio' versus [ma.ˈri.a] *Maria* 'Maria', [a.ˈloː.a] *Aloha* 'Aloha', [haˈʋaː.i] *Hawaii* 'Hawaii', [roˈmeː.o] *(Alfa) Romeo* '(Alfa) Romeo'. The analysis characterizes antepenultimate stress as exceptional; I have no independent evidence for this prediction.

for the purposes of stress assignment. Thus, [spa.ˈ(χɛt.ti)] *spaghetti* ‘spaghetti’ has the same stress pattern as [a.ˈ(lɑs.ka)]. *Alaska* ‘Alaska’. This fact forms one of the arguments for the ambisyllabicity of consonants after short last vowels. In the context of this chapter, however, it is relevant to observe that there are a few exceptions to the pattern of *Alaska* (cf. *Helsinki*, *Istanbul*, *Kazachstan*, *Washington*, *badminton* ‘badminton’, [(ˈtaː.lis).(mɑn)] *talisman* ‘talisman’), but none to the pattern of *spaghetti*.[11] First, the rare exceptions to penultimate stress in trisyllabic or longer words with closed penults can be dealt with by marking the antepenultimate syllable as a foot head, as shown in tableau (43).

(43)

(kazaχstan	AllFtRt	NoClash	FootBin	FaithFoot	NonFin	WSP/SWP	F’Rt
☞a. ˈ(kaː.zɑχ)(stɑn)						*	*
b. ˈ(kaː).(zɑχ.stɑn)		*!				*	*
c. kaˈ.(zɑχ.stɑn)				*!		*	
d. (kaː.zɑχ)ˈ(stɑn)					*!	*	
e. ˈ(kaː.zɑχ.stɑn)			*!			**	

The solution to the impossible (40d) is sought in the distributional restriction of ambisyllabic consonants. An ambisyllabic consonant cannot be a coda in a foot and an onset in a following foot in underived words. While ambisyllabic consonants happily straddle the boundary between an unfooted syllable and a foot, as shown in (44), they cannot straddle the boundary between two feet. (Since AllFtRt ensures that there are no unfooted syllables after a foot, the mirror-image situation of an ambisyllabic consonant forming the coda inside a foot and an onset in a following unfooted syllable does not occur.) The applicable constraint therefore is CrispEdge (Ito and Mester 1999), which militates against multiple linkings across some constituent boundary. Their discussion is largely with reference to double linkages across syllable boundaries (shared place features, geminates, ambisyllabic consonants), but they also refer to a restriction of ambisyllabic consonants in English to non-foot-initial position. Dutch, then, excludes ambisyllabic consonants from foot-final position, as expressed in (45) in the formulation of Basri *et al.* (1999).

(44) a. ɑn.ˈ(naː.l) *annaal* ‘annal’ (cf. a.ˈ(naː.l) *anaal* ‘anal’)
b. ˈ(ɑn.na).(nɑs) *ananas* ‘pineapple’ (*[ˈɑn.nɑn.ˌnɑs])
c. baˈ(lu.χi).(stɑn) *Baluchistan* ‘Baluchistan’ (*baˈ(lu.χɪs).(stɑn])

[11] *Talisman* could be analyzed as a compound $(\text{taːlis})_{\omega}$ $(\text{mɑn})_{\omega}$, but it is not the case that this stress pattern can be generally analyzed as a compound. This is shown by n-Deletion, which deletes prosodic-word-final schwa, as in $\text{ˈ(mɛn.sə)}_{\omega}$ $(\text{vɛrk})_{\omega}$ *mensenwerk* ‘work by people’ (as in *Het blijft mensenwerk* ‘We are only human and can make mistakes’; cf. $\text{ˈ(mɛn.sən.dik)}_{\omega}$ *Mensendieck* (proper name)).

(45) CrispEdge(Foot,Rt): Linking across the right edge of a foot is prohibited.

It is the violation of CrispEdge(Foot,Rt), therefore, that explains the impossible stress pattern in (40d) and the difference with the highly exceptional, but attested stress pattern of words like *Kazachstan* and *Helsinki*.[12]

9.7 Proper names

There are regular pronunciations of placenames that violate the grammar outlined above. There are two types. The first consists of two subtypes. Numerous trisyllabic names with initial main stress and secondary stress on the penult exist, like [ˈbɛr.ˌlaː.χə] *Berlage*, [ˈbuː.ˌrɪχ.tər] *Boerigter*, [ˈnɛi.ˌmeːχə] *Nijmegen*, and also numerous quadrisyllabic names with initial main stress, like [ˈɑm.stənˌraː.də] *Amstenrade*, [ˈaː.məˌrɔ.ŋə] *Amerongen*, [ˈχʏs.sənˌhoːvə] *Gussenhoven*, [ˈʊŋ.kəlˌhaːχə] *Winkelhagen*, etc. The point is that there are no convincing examples of this exceptional pattern that are *not* placenames. These words cannot be analyzed as compounds. For instance, the high vowel in the first syllable of *Boerigter* would be short if the next part were the second element of a compound, as in *Boe-roeper* 'taunter', and the medial [n] in *Gussenhoven* would be deleted if it ended the first element of a compound, as in [ˈtʏs.səˌhɑl.tə] *tussenhalte* 'intermediate stop'. These words are most probably to be analyzed as morphologically complex, but apparently form single phonological words. This is also the reason why words like *Kazachstan* are taken to be single phonological words (see footnote 11). Indeed, these should be characterized as allowable *exceptions*, as predicted by our grammar (cf. (40)). However, the two types of word discussed in this paragraph, of which there are many and which are in no way felt to be anomalous by native speakers, are not to be classed as exceptions, and require some special treatment.

Second, there are many phrasal proper names that have initial main stress, like [ˈsprɪ.ŋənt.ˌfɛlt] *Spring in 't Veld* '*Lit*. cavorter in the field', [ˈnaːkt.χə.ˌboː.rə] *Naaktgeboren* '*Lit*. born naked', [ˈvru.χən.də.ˌʋɛi] *Vroegindewei* '*Lit*. early in the field'. These can be analyzed as compounds, as in [(vru.χən.də)$_{\omega}$ (ʋɛi)$_{\omega}$].

9.8 Conclusion

The aim of this chapter was to show that Dutch word stress, which can be described by the OT grammar in (46), allows a treatment of exceptions whereby attested exceptions are predicted by free lexical marking of foot heads, with or without main stress, while unattested stress patterns cannot be generated.

[12] In derived words, CrispEdge(F) is not enforced, as evidenced by *kanonnier* (kɑn.nɔn).ˈ(niːr), from kaˈ(nɔn) + ˈ(iːr) (example from Booij 1999).

(Undominated constraints, like the constraint that ensures that all words have main stress, are not considered.)

(46) CrispEdge(Ft,Rt), AllFtRt > NoClash, FootBin > SHSP > NonFin > WSP/SWP > F'Right

The generalizations that are expressed by (46) are listed, as follows (cf. Gussenhoven 2009).

SHSP > NonFin:	Final superheavy syllables have word stress (*kapitein*).
NoClash > WSP/SWP:	A disyllabic foot for a disyllable (*Alec*) and word-initial pre-stress syllables are unfooted (*Palembang*).
NonFin > WSP/SWP:	No word stress on a final closed syllable in disyllables (*Alec*).
NonFin > F'Right:	No word stress on a final closed syllable in trisyllables (*marathon*, *Palembang*).
WSP/SWP > F'Right:	Trisyllables with final closed syllable and open penult have antepenultimate stress (*marathon*) and before the word stress, consonants do not project a mora (*armada*).
AllFeetRt > FootBin:	No unparsed syllables at the word end (*weduwe*).
Hiatus > FootBin:	A trisyllabic foot for trisyllables ending in high vowel and schwa (*weduwe*).

The way in which attestable exceptions can be described is by ranking FaithFoot between FootBin and SHSP. FaithFoot will respect marked foot heads and marked foot heads with a main stress marking. Only the beginnings of feet need to be marked, in accordance with Idsardi's theory (Idsardi 2009). However, unlike what is assumed in that theory, we needed to mark main stress in cases like *chocolá* (to beat Nonfin) and *ólifant* (to beat SHSP). The way the attested exceptional stress positions are described and the unattested ones are excluded is itemized below.[13]

(47) CrispEdge(Ft,Rt), AllFtRt > FootBin > FaithFoot > SHSP, NoClash, NonFin > WSP/SWP > F'Right

FaithFoot > F'Right:	Initial stress in trisyllables with open syllables (*Canada*).

[13] A reviewer raised the interesting question of whether underlyingly marked foot structure interferes with stress shifts in morphological derivations. The answer is that it does not (e.g. footnote 12). Word-formation rules must therefore be allowed to ignore the lexical markings of the sort used in this chapter. A treatment is beyond its scope.

FAITHFOOT > NONFIN:	Final stress in disyllables and trisyllables (*kanon*, *chocola*).
FAITHFOOT > WSP/SWP:	Penultimate stress in trisyllables with final closed syllable and open penult (*Honduras*) and initial stress in trisyllables with final and penultimate closed syllables (*Kazachstan*).
FAITHFOOT > SHSP:	Superheavy final syllables are weak in disyllables (*kleinood*) and have no word stress in trisyllables (*ooievaar*).
FOOTBIN > FAITHFOOT:	An initial lexical foot is not respected in favor of a trisyllabic foot in trisyllables ending in schwa (*ballade*).
NOCLASH > FAITHFOOT:	An initial lexical foot is not respected in favor of an initial monosyllabic foot in trisyllables ending in schwa (*ballade*).
CRISPEDGE(FT,RT) > FAITHFOOT:	An initial lexical foot is not respected in trisyllables with an ambisyllabic consonant in the onset of the final syllable (*vendetta*).

Unattested words with main stress on preantepenultimate syllables could be accounted for by allowing the lexically marked main stress to survive the strictures of the grammar, alongside a generated penultimate stress. It was suggested that, post-lexically, any main stress before the last main stress is ignored by the intonation grammar that inserts pitch accents in main stressed syllables.

By considering a maximal data set, larger than has been considered in any previous publication, it also became clear that there are geographical and proper names that fall outside our grammar. One type is represented by *Nijmegen*, which has the structure [ˈ(nɛi).(meːχ ə)]. The clash here would not be tolerated outside the domain of proper names (cf. *balláde*). The number of proper names with this pattern is high. The second type concerns quadrisyllabic words like [ˈ(aː.mə).(rɔ.ŋə)] *Amerongen*, which have initial main stress, something we were at pains to exclude from the set of attested exceptions. By contrast, the word pattern of [ˈ(ɪs.stɑm).(bul)] *Istanbul* is rare even in geographical names, and rarer still in nouns. It is exactly for this reason that it was decided that this pattern ought to be allowed to exist *as an exception*, as opposed to a special category that is looked after by an extended grammar for proper names.[14] This

[14] Admittedly, there are many surnames of Frisian origin that show this exceptional pattern, like [ˈtɑm.mɪŋ.ˌχaː] *Tamminga*.

was done without resorting to claims that words are compounds when there is no independent evidence for that analysis.

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10 Symmetries and asymmetries in secondary stress patterns

Brett Hyde

10.1 Introduction

A long-standing observation about the typology of Quantity-Insensitive binary stress systems is that patterns that appear to be based on trochaic feet are attested in a greater variety than patterns that appear to be based on iambic feet (Kager 1993; Hayes 1995; van de Vijver 1998; Hyde 2002; Alber 2005; among others).[1] While this typological imbalance is typically discussed in terms of parsing directionality – directional parsing patterns found among trochaic systems are very often absent among iambic systems – we can gain a better understanding of the disparity by considering the patterns of attestation in mirror-image pairs.

In mirror-image stress patterns, stressed and unstressed positions alternate in the same way, but the alternation starts from opposite edges. As examples, consider the mirror image pairs in (1a) and (1b). The (1a) pattern stresses every odd-numbered syllable from the left. Its mirror image, (1b), stresses every odd-numbered syllable from the right. Both patterns are attested. The (1a) pattern can be found in Maranungku (Tryon 1970) and the (1b) pattern in Suruwaha (Everett 1996).

(1)

```
a. x   x   x          b.     x   x   x
   σ σ σ σ σ σ            σ σ σ σ σ σ

   x   x   x   x        x   x   x   x
   σ σ σ σ σ σ σ        σ σ σ σ σ σ σ
   Attested                  Attested
```

The patterns in (2) differ only slightly from those in (1). In (2a), stress appears on every odd-numbered syllable from the left *except the final syllable*, resulting in a lapse at the right edge in the odd-parity form. In the mirror image, (2b), stress appears on every odd-numbered syllable from the right *except the initial syllable*, resulting in a lapse at the left edge. However, only one of the patterns

[1] Thanks to the editor, Harry van der Hulst, and to two anonymous reviewers for a number of helpful comments and suggestions. They led to significant improvements throughout the chapter.

in this pair is actually attested. The (2a) pattern can be found in Pintupi (Hansen and Hansen 1969), but there appears to be no language that exhibits the (2b) pattern.

(2)

a.	b.
x x x	x x x
σ σ σ σ σ σ	σ σ σ σ σ σ
x x x	x x x
σ σ σ σ σ <u>σ σ</u>	<u>σ σ</u> σ σ σ σ σ σ
Attested	*Unattested*

There are two advantages to considering patterns of attestation in terms of mirror-image pairs like those in (1) and (2). The first is that it allows us to examine iambic–trochaic asymmetries from a more theory-neutral perspective. In general, if one member of a mirror-image pair can be characterized as trochaic – most easily created with trochaic feet – then the second member can be characterized as iambic – most easily created with iambic feet. As examples, the patterns in (1) and (2) are reproduced with feet in (3) and (4), respectively, as they might be constructed in familiar Weak Layering (Itô and Mester 1992) accounts such as McCarthy and Prince (1993), Kager (2001, 2005), and Alber (2005).

(3)

a. Trochaic: Attested	b. Iambic: Attested
(σ́σ)(σ́σ)(σ́σ)	(σσ́)(σσ́)(σσ́)
(σ́σ)(σ́σ)(σ́σ)(σ́)	(σ́)(σσ́)(σσ́)(σσ́)

(4)

a. Trochaic: Attested	b. Iambic: Unattested
(σ́σ)(σ́σ)(σ́σ)	(σσ́)(σσ́)(σσ́)
(σ́σ)(σ́σ)(σ́<u>σ)σ</u>	<u>σ(σ</u>σ́)(σσ́)(σσ́)

The ability to characterize the relevant mirror-image pairs as iambic–trochaic pairs allows us to examine iambic–trochaic asymmetries from a more neutral perspective. Since mirror-image pairs are not actually constructed based on any particular view of prosodic or metrical structure, or on any particular set of assumptions about the devices that produce directionality effects, the study need not make any commitment to a particular view or set of assumptions.

The second advantage of considering mirror-image pairs is that it allows for comparison of patterns that are metrically similar. In mirror-image pairs, both members either avoid clash (adjacent stressed syllables) and lapse (adjacent stressless syllables) altogether or they exhibit clash or lapse in corresponding positions. In (1/3), for example, neither member of the pair contains a clash or lapse. In (2/4), there is a lapse at the right edge in the odd-parity trochaic form and a corresponding lapse at the left edge in the odd-parity iambic form. In contrast, when the comparison is between iambic and trochaic stress patterns

created with the same directional parsing patterns, the comparison is between metrical apples and oranges. When a string of syllables is parsed into trochaic feet from right to left, as in (5a), for example, the result is a stress pattern with neither clash nor lapse. When a string of syllables is parsed into iambic feet from right to left, as in (5b), the result is lapse at the left edge in the odd-parity form.

(5)

a. Right-to-left trochees	b. Right-to-left iambs
(σ́σ)(σ́σ)(σ́σ)	(σσ́)(σσ́)(σσ́)
σ(σ́σ)(σ́σ)(σ́σ)	σ(σσ́)(σσ́)(σσ́)

In allowing us to compare patterns that are metrically similar, examination of mirror-image pairs allows us to make generalizations based on metrical characteristics, generalizations that may not emerge otherwise. In this chapter, I focus on the mirror-image pairs in (6) and (7) and the three generalizations in (8). The two pairs in (6) are patterns that contain neither clash nor lapse. Only four such patterns are possible, and the two pairs consist of exactly these four. Each of the patterns in both pairs is attested.

(6) Patterns without clash or lapse: symmetrically attested

a. i. Trochaic: Attested

```
  x   x   x
σ σ σ σ σ σ

  x   x   x
σ σ σ σ σ σ σ
```

ii. Iambic: Attested

```
  x   x   x
σ σ σ σ σ σ

  x   x   x
σ σ σ σ σ σ σ
```

b. i. Trochaic: Attested

```
x   x   x
σ σ σ σ σ σ

x   x   x   x
σ σ σ σ σ σ σ
```

ii. Iambic: Attested

```
  x   x   x
σ σ σ σ σ σ

x   x   x   x
σ σ σ σ σ σ σ
```

The mirror-image pairs in (7) consist of basically binary patterns that contain either a clash or a lapse. While many more pairs with either a clash or a lapse are possible, only those pairs where at least one of the members is attested are considered here. Note that there appear to be no mirror-images pairs with clash or lapse where both members are attested (but see section 10.4 for discussion of a possible counterexample).

(7) Patterns with clash or lapse: asymmetrically attested

a. i. Trochaic: *Unattested*

```
    x   x
σ σ σ σ σ σ

  x   x   x
σ σ σ σ σ σ σ
```

ii. Iambic: Attested

```
  x   x
σ σ σ σ σ σ

  x   x   x
σ σ σ σ σ σ σ
```

b. i. Trochaic: *Unattested*

```
  x x   x
σ σ σ σ σ σ

x   x   x
σ σ σ σ σ σ σ
```

ii. Iambic: Attested

```
x   x x
σ σ σ σ σ σ

x   x   x
σ σ σ σ σ σ σ
```

c. i. Trochaic: Attested

```
x   x   x
σ σ σ σ σ σ

x   x   x
σ σ σ σ σ σ σ σ
```

ii. Iambic: *Unattested*

```
  x   x   x
σ σ σ σ σ σ

  x   x   x
σ σ σ σ σ σ σ
```

d. i. Trochaic: Attested

```
x   x   x
σ σ σ σ σ σ

x   x   x
σ σ σ σσ σ σ
```

ii. Iambic: *Unattested*

```
  x   x   x
σ σ σ σ σ σ

  x   x   x
σ σ σσ σ σ σ
```

e. i. Trochaic: Attested

```
  x   x   x
σ σ σ σ σ σ

x x   x   x
σ σ σ σ σ σ σ
```

ii. Iambic: *Unattested*

```
  x   x   x
σ σ σ σ σ σ

  x   x   x x
σ σ σ σ σ σσ
```

f. i. Trochaic: Attested

```
  x   x   x
σ σ σ σ σ σ

x   x   x
σ σσ σ σ σ σ
```

ii. Iambic: *Unattested*

```
  x   x   x
σ σ σ σ σ σ

  x   x   x
σ σ σ σ σσ σ
```

From consideration of the mirror-image pairs in (6) and (7), we can arrive at the generalizations in (8). The generalizations in (8a, b) tell us about the distribution of iambic–trochaic asymmetries. There are no iambic–trochaic asymmetries among patterns that avoid clash and lapse. Such patterns are always attested in mirror-image pairs. The trochaic version is attested and the iambic mirror image is attested. Instead, iambic–trochaic asymmetries are characteristic among patterns that fail to avoid clash and lapse. If the trochaic version is attested in a mirror-image pair, the iambic version is not. If the iambic version is attested, the trochaic version is not.

(8)
a. In mirror-image patterns with neither clash nor lapse, as in (6), both members of the pair are attested.
b. In mirror-image patterns with either clash or lapse, as in (7), at most one member of the pair is attested.
c. Attested patterns with clash or lapse always have stress on the initial syllable, always leave the final syllable stressless, or both.

The generalization in (8c) provides a clue to the reasons that arhythmic configurations like clash or lapse arise – and, therefore, a clue to the reasons that iambic–trochaic asymmetries arise. When clash or lapse arises, it arises near a form's left edge to accommodate an initial stressed syllable or near its right edge to accommodate a final stressless syllable. In other words, a clash or lapse arises only in order to satisfy INITIAL STRESS (Prince 1983; Hyde 2002) or NONFINALITY (Prince and Smolensky 1993; Hyde 2002, 2003).

(9) a. INITIAL STRESS: The initial syllable of the prosodic word is stressed.
b. NONFINALITY: The final syllable of the prosodic word is stressless.

Since iambic patterns are incompatible with initial stress and final stresslessness, INITIAL STRESS and NONFINALITY tend to prefer trochaic patterns.

Although the chapter's primary purpose is to focus on generalizations that are most easily grasped when the issues of feet and parsing directionality are set aside, it will be useful to see how these generalizations can be captured in a foot-based theory designed to accommodate them. To this end, I will interleave discussion of the different generalizations with a demonstration of how they are captured in the Weak Bracketing approach of Hyde (2001, 2002). The Weak Bracketing approach differs from the more familiar Weak Layering approaches mentioned above in several key respects. Among these are its toleration of improperly bracketed – or 'overlapping' – feet and its more flexible relationship between feet and stress. Though I will not address them in detail here, there are several motivations for the Weak Bracketing approach. It predicts an accurate typology of Quantity-Insensitive binary stress patterns (Hyde 2002), it retains the well-motivated binary foot as a prosodic category (Hermans 2011), and it avoids the Odd-Parity Input Problem, a set of pathological predictions that arise under Weak Layering (Hyde 2008b, 2009, forthcoming).[2] For an alternative approach addressing many of the same issues discussed below, see van der Hulst (this volume, chapter 11).

10.2 The perfect alternation patterns

In this section, we examine the evidence for the generalization in (8a): mirror-image patterns that contain neither clash nor lapse are symmetrically attested. In such patterns, which I will refer to as *perfect alternation* (Prince 1983) patterns, stressed and unstressed syllables follow each other in perfect binary alternation.

[2] The Odd-Parity Input Problem consists of two subproblems, the Odd Heavy Problem and the Even Output Problem. The Odd Heavy Problem is a pathological type of Quantity Sensitivity that arises under Weak Layering accounts in analyses previously thought to produce Quantity-Insensitive systems. The Even Output Problem is the conversion of odd-parity inputs to even-parity outputs to achieve exhaustive binary parsing.

Only four perfect alternation patterns are possible, and they form two mirror-image pairs. The first pair of patterns, which I will refer to as *minimal alternation* patterns, have the fewest stresses possible without containing a lapse. The trochaic version, (10a), stresses every even-numbered syllable counting from the right. It can be found in Nengone (Tryon 1967) and Warao (Osborn 1966).[3] The iambic mirror image, (10b), stresses every even-numbered syllable counting from the left. It can be found in Araucanian (Echeverria and Contreras 1965).[4]

(10) Minimal alternation

a. Trochaic: Attested	b. Iambic: Attested
x x x	x x x
σ σ σ σ σ σ	σ σ σ σ σ σ
x x x	x x x
σ σ σ σ σ σ σ	σ σ σ σ σ σ σ

In accord with the generalization in (8a), then, the minimal alternation patterns form a mirror-image pair, and each pattern in the pair is attested. Next, we see how the minimal alternation patterns emerge under the Weak Bracketing approach.

The Weak Bracketing approach departs in two fundamental ways from the more familiar Weak Layering approach found, for example, in the proposals of McCarthy and Prince (1993), Kager (2001, 2005), and Alber (2005). The Weak Bracketing approach requires exhaustive parsing of syllables into feet, and it allows disyllabic feet to overlap so that they share a syllable. The departures have consequences primarily in the parsing of odd-parity forms. Weak Layering approaches allow the odd, leftover syllable of odd-parity forms either to be parsed as a monosyllabic foot or to remain unfooted. In the Weak Bracketing approach, however, the leftover syllable can either be parsed as a monosyllabic foot, or it can be parsed into a disyllabic foot that overlaps another disyllabic foot. It cannot remained unfooted.

Perhaps the most important consequence of allowing two feet to share a syllable is that it also allows two feet to share a stress. When two disyllabic feet overlap, as in the odd-parity forms of the minimal alternation patterns in (11), they can share the stress that occurs over their common syllable. I will refer to such structures as *gridmark-sharing* configurations. Note that the Weak Bracketing approach maintains a distinction between *stress*, indicated

[3] Gordon (2002) lists ten additional languages that exhibit the trochaic minimal alternation pattern: Anejom, Berbice, Cavineña, Ese Ejja, Larike, Malakmalak, Orokolo, To'aba'ita, Tukang Besi, and Ura.

[4] Gordon (2002) lists two additional languages that exhibit the iambic minimal alternation pattern: Hatam and Sirenikski.

by a gridmark *x* above a syllable, and *head*, indicated by a vertical association line. While overlapping feet may share a stress, they must have a unique head syllable.

(11) Minimal alternation

a. Trochaic: Attested

```
x   x   x
σ σ σ σ σ σ
 ↙   ↙   ↙

x   x   x
σ σ σ σ σ σ σ
↙↙   ↙   ↙
```

b. Iambic: Attested

```
  x   x   x
σ σ σ σ σ σ
 ↘   ↘   ↘

  x   x   x
σ σ σ σ σ σ σ
 ↘   ↘   ↘↘
```

In allowing feet to share a stress, the Weak Bracketing approach departs from the traditional one-to-one correspondence between feet and stress (Selkirk 1980). As we shall see further below, it departs from the traditional approach in allowing feet to remain stressless, as well. While the Weak Bracketing approach is unique in allowing feet to share a stress, stressless feet can also be found in the proposals of Hayes (1987), Tyhurst (1987), Hung (1993, 1994), Selkirk (1995), Crowhurst (1996), and Buckley (2009), among others.

In the context of binary stress systems, the primary benefit of allowing gridmark-sharing configurations is that they make it more difficult for the grammar to introduce clash and lapse. Consider, for example, how the trochaic pattern in (11a) fares against its closest competitors with respect to *Clash and MapGridmark, given in (12).

(12) a. *Clash: Foot-level gridmarks do not occur on adjacent syllables.

b. MapGridmark: Every foot has a foot-level gridmark within its domain.

As (13) illustrates, a gridmark-sharing configuration allows the minimal alternation pattern to best its closest competitors. *Clash excludes candidate (b), where a monosyllabic foot at the left edge creates a clash with the following trochee. MapGridmark excludes candidate (c), where a stressless disyllabic foot helps to avoid clash by creating a lapse instead. By avoiding monosyllabic and stressless feet, candidate (a) satisfies both constraints simultaneously. It satisfies *Clash because it does not have adjacent stressed syllables, and it satisfies MapGridmark because each foot has a stress within its domain. (Since the Weak Bracketing approach requires exhaustive parsing, candidates with unparsed syllables are not considered.)

(13)

σσσσσσσ	*Clash	MapGridmark
☞ a. x x x σ σ σ σ σ σ σ		
b. x x x x σ σ σ σ σ σ σ	*!	
c. x x x σ σ σ σ σ σ σ		*!

In addition to *Clash and MapGridmark, two alignment constraints are crucial in producing the minimal alternation patterns. They are formulated here using the Relation-Specific Alignment (RSA) approach of Hyde (2008a, 2012). The advantage of RSA constraints is that they avoid a set of pathological predictions, first identified by Eisner (1997), that are associated with the more familiar Generalized Alignment formulation (McCarthy and Prince 1993). In the RSA approach, alignment constraints have two components, separated by a slash, as in (14). The set of categories to the left of the slash is prohibited from occurring in the configuration of misalignment indicated to the right of the slash. The prohibited configuration of misalignment is one where a separator category, *SCat*, intervenes between an edge of the first aligned category, *ACat1*, and an edge of the second aligned category, *ACat2*. Because it prohibits *SCat* from intervening between the left edges of *ACat1* and *ACat2*, for example, (14a), requires alignment of left edges. Similarly, because it prohibits *SCat* from intervening between the right edges of *ACat1* and *ACat2*, (14b) requires alignment of right edges.

(14) Alignment constraint schemas

a. Left-edge: *⟨ACat1, ACat2, (SCat)⟩ / [. . . SCat . . . ACat2 . . .]$_{\text{ACat1}}$
'Assess a violation mark for every ⟨ACat1, ACat2, (SCat)⟩ such that SCat precedes ACat2 within ACat1.'

b. Right-edge: *⟨ACat1, ACat2, (SCat)⟩ / [. . . ACat2 . . . SCat . . .]$_{\text{ACat1}}$
'Assess a violation mark for every ⟨ACat1, ACat2, (SCat)⟩ such that ACat2 precedes SCat within ACat1.'

Notice that both of the aligned categories are included in the set to the left of the slash, but the separator category is only optionally included. When an alignment constraint omits the separator category from this set, violation assessment is distance-insensitive: a single violation is assessed for each pair of

misaligned categories. When the set includes the separator category, violation assessment is distance-sensitive: the number of violations assessed is equal to the number of separator categories intervening between each pair of misaligned edges.

The two alignment constraints that help to produce the minimal alternation patterns are the distance-sensitive ALL-HEADS-LEFT and ALL-HEADS-RIGHT, given in (15). ALL-HEADS-LEFT aligns the head syllables of feet towards the left edge of the prosodic word, and ALL-HEADS-RIGHT aligns head syllables towards the right edge.

(15) a. ALL-HEADS-LEFT: $*\langle\omega, \sigma_{Hd}, \sigma\rangle$ / $[\ldots\ \sigma\ \ldots\ \sigma_{Hd}\ \ldots]_{\omega}$
'Assess a violation mark for every $\langle\omega, \sigma_{Hd}, \sigma\rangle$ such that σ precedes σ_{Hd} within ω.'

b. ALL-HEADS-RIGHT: $*\langle\omega, \sigma_{Hd}, \sigma\rangle$ / $[\ldots\ \sigma_{Hd}\ \ldots\ \sigma\ \ldots]_{\omega}$
'Assess a violation mark for every $\langle\omega, \sigma_{Hd}, \sigma\rangle$ such that σ_{Hd} precedes σ within ω.'

ALL-HEADS-LEFT and ALL-HEADS-RIGHT have two roles in producing the minimal alternation patterns. The first is that they determine the directional orientation of feet within the prosodic word, the standard role of alignment constraints in this context. Because ALL-HEADS-LEFT and ALL-HEADS-RIGHT align the head syllables of feet, however, rather than the feet themselves, they also determine foot type (whether the syllables are parsed into trochees or iambs). As (16) and (17) demonstrate, ALL-HEADS-LEFT prefers footing that is both leftward and trochaic, resulting in the trochaic minimal alternation pattern. It draws feet to the left edge of the prosodic word, but it also draws head syllables to the left edges of the individual feet. Similarly, ALL-HEADS-RIGHT prefers footing that is both rightward and iambic, yielding the iambic minimal alternation pattern. It draws feet to the right edge of the prosodic word, and it draws head syllables to the right edges of the individual feet.

(16) Even-parity

σσσσσσ	ALL-HEADS-LEFT	ALL-HEADS-RIGHT
a. x x x σ σ σ σ σ σ	☞ ** ****	***** *** *
b. x x x σ σ σ σ σ σ	* *** *****	☞ **** **

(17) Odd-parity

σσσσσσσ	ALL-HEADS-LEFT	ALL-HEADS-RIGHT
a. x x x σ σ σ σ σ σ σ	☞ * *** *****	****** ***** *** *
b. x x x x σ σ σ σ σ σ σ	** **** ******	****** **** **
c. x x x x σ σ σ σ σ σ σ	** **** ******	****** **** **
d. x x x σ σ σ σ σ σ σ	* *** ***** ******	☞ ***** *** *

The second pair of perfect alternation patterns are the *maximal alternation* patterns. They have the most stresses possible without containing a clash. The trochaic version, (18a), stresses every odd-numbered syllable counting from the left. It can be found in Maranungku (Tryon 1970) and Ningil (Manning and Saggers 1977).[5] The iambic mirror image, (18b), stresses every odd-numbered syllable counting from the right. It can be found in Suruwaha (Everett 1996), Tubatulabal (Voegelin 1935), and Weri (Boxwell and Boxwell 1966).[6]

(18) Maximal alternation

a. Trochaic: Attested

x x x
σ σ σ σ σ σ

x x x x
σ σ σ σ σ σ σ

b. Iambic: Attested

x x x
σ σ σ σ σ σ

x x x x
σ σ σ σ σ σ σ

Note that the maximal alternation patterns also conform to the generalization in (8a). The two patterns form a mirror-image pair, and each pair in the pattern is attested.

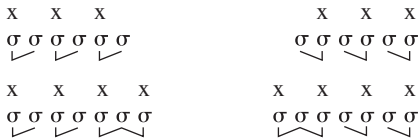
Gridmark-sharing configurations do not play the central role in producing maximal alternation patterns that they play in producing minimal alternation

[5] Gordon (2002) lists twelve additional languages that exhibit the trochaic maximal alternation pattern: Bagandji, Czech, Hungarian, Icelandic, Livonian, Mansi, Murinbata, Ono, Panamint, Sinaugoro, Timucua, and Votic.

[6] Gordon (2002) lists four additional languages that exhibit the iambic maximal alternation pattern: Asmat, Chulupi, Kamayur, and Urubú Kaapor.

patterns. As (19) illustrates, since it is never the case that two head syllables are adjacent in the minimal alternation pattern, there is no danger of clash when each is stressed, and there is no need for gridmark-sharing to avoid clash.

(19) a. Trochaic: Attested b. Iambic: Attested



In the Weak Bracketing approach, the maximal alternation patterns result from conflicting directionality in the alignment of head syllables. Two additional alignment constraints are necessary, the distance-insensitive HEAD-LEFT and HEAD-RIGHT, given in (20). HEAD-LEFT anchors a single head syllable at the left edge of the prosodic word, and HEAD-RIGHT anchors a single syllable at the right edge.

(20) a. HEAD-LEFT: $*\langle\omega, \sigma_{Hd}\rangle$ / [. . . σ . . . σ_{Hd} . . .]$_\omega$
'Assess a violation mark for every $\langle\omega, \sigma_{Hd}\rangle$ such that σ precedes σ_{Hd} within ω.'

b. HEAD-RIGHT: $*\langle\omega, \sigma_{Hd}\rangle$ / [. . . σ_{Hd} . . . σ . . .]$_\omega$
'Assess a violation mark for every $\langle\omega, \sigma_{Hd}\rangle$ such that σ_{Hd} precedes σ within ω.'

When HEAD-LEFT dominates ALL-HEADS-RIGHT, the former anchors a single head syllable at the prosodic word's left edge and the latter draws the remaining head syllables as far to the right as possible. The result, as (21) and (22) illustrate, is trochaic maximal alternation.

(21) Even-parity

σσσσσσ	HEAD-LEFT	ALL-HEADS-RIGHT
☞ a. x x x / σ σ σ σ σ σ	* *	***** *** *
b. x x x / σ σ σ σ σ σ	* * *!	**** **

(22) Odd-parity

σσσσσσσ	HEAD-LEFT	ALL-HEADS-RIGHT
☞ a. x x x x σ σ σ σ σ σ σ	* * *	****** **** **
b. x x x σ σ σ σ σ σ σ	* * * *!	***** *** *

Similarly, when HEAD-RIGHT dominates ALL-HEADS-LEFT, the former anchors a single head syllable at the right edge of the prosodic word and the latter draws the remaining head syllables as far to the left as possible. The result is iambic maximal alternation. I omit the additional tableaux.

To this point then, we have seen that there are only four possible perfect alternation patterns, that each is attested, and that the Weak Bracketing approach produces all four. If limited to the constraints discussed above, however – MAPGRIDMARK, *CLASH, and the four alignment constraints – the perfect alternation patterns are the *only* patterns that the Weak Bracketing approach produces. To produce additional patterns, it is necessary to posit additional constraints that can introduce clash and lapse in the appropriate positions.

10.3 Departures from perfect alternation

In this section, we examine departures from perfect alternation that might be created by requiring initial stress or final stresslessness and compare them to mirror-image patterns that might be created by requiring final stress or initial stresslessness. In examining such pairs, we find support for the generalization in (8b) that at most one member is attested in mirror-image pairs that depart from perfect alternation and the generalization in (8c) that NONFINALITY and INITIAL STRESS are responsible for attested cases of clash and lapse.

10.3.1 Variations on minimal alternation due to final stresslessness

The first group of departures from perfect alternation can be thought of as variations on minimal alternation created by preventing a peripheral stress. For comparison, the minimal alternation patterns are repeated in (23).

(23) Minimal alternation

a. Trochaic

```
  x   x   x
σ σ σ σ σ σ

  x   x   x
σ σ σ σ σ σ σ
```

b. Iambic

```
  x   x   x
σ σ σ σ σ σ

  x   x   x
σ σ σ σ σ σ σ
```

Deleting a final stress from the iambic minimal alternation pattern creates a lapse at the right edge in even-parity forms, as in (24b). Stress occurs on every even-numbered syllable from the left except the final syllable. The pattern can be found in Choctaw (Nicklas 1972, 1975) and Hixkaryana (Derbyshire 1985).[7] Deleting an initial stress from the trochaic minimal alternation pattern creates a lapse at the left edge in the mirror image (24a). Stress occurs on every even-numbered syllable from the right except the initial syllable. The pattern is unattested.

(24) a. Trochaic: *Unattested*

```
        x   x
σσ σ σ σ σ

  x   x   x
σ σ σ σ σ σ σ
```

b. Iambic: Attested

```
  x   x
σ σ σ σ σσ

  x   x   x
σ σ σ σ σ σ σ
```

The asymmetrical formulation of the NonFinality constraint accounts for the asymmetrical attestation of the patterns in (24). Because it only prohibits stress on final syllables, Nonfinality can prevent final stress to create (24b) as a variation on iambic minimal alternation, but it cannot prevent initial stress to create the mirror image (24a) as a variation on trochaic minimal alternation.

To see how Nonfinality's asymmetrical formulation yields the correct predictions in the Weak Bracketing approach, recall from section 10.2 that *Clash, MapGridmark, and the foot-head alignment constraints are capable of producing only the four patterns with perfect alternation. When Nonfinality is added to the constraint set, however, it allows the grammar to create a lapse at the right edge of the prosodic word. As (25) demonstrates, under a ranking where NonFinality, *Clash, and All-Heads-Right all dominate MapGridmark, the (24b) pattern is preferred to iambic minimal alternation. The final foot is left stressless in even-parity forms in violation of MapGridmark, resulting in a final lapse.

[7] Choctaw and Hixkaryana are both Quantity Sensitive. The (24b) pattern is the pattern found in forms that contain only (underlyingly) light syllables.

(25)

σσσσσσ	NON-FIN	*CLASH	ALL-HDS-R	MAPGM
☞ w. x x / σ σ σ σ σ σ			6	1
a. x x x / σ σ σ σ σ σ	W 1		6	L
b. x x x / σ σ σ σ σ σ		W 1	W 7	L

While the addition of NONFINALITY to the constraint set allows the grammar to produce the attested iambic pattern in (24b), it does not allow it to produce the unattested trochaic mirror image in (24a). As tableau (26) demonstrates, the trochaic version is harmonically bounded by trochaic minimal alternation.

(26)

σσσσσσ	NON-FIN	MAPGM	*CLASH	ALL-HDS-L
☞ w. x x x / σ σ σ σ σ σ				6
l. x x / σ σ σ σ σ σ		W 1		6

Next, consider the patterns in (27), variations on minimal alternation created by shifting a peripheral stress inward. Shifting a final stress from the iambic minimal alternation pattern one syllable to the left, as in (27b), results in clash just before the final syllable in even-parity forms. Stress occurs on the penult and on every even-numbered syllable from the left that precedes the penult. The pattern can be found in Aguaruna (Payne 1990; Hung 1994), Southern Paiute (Sapir 1930), and Axininca Campa (Payne 1981). Shifting an initial stress from trochaic minimal alternation rightward, as in the mirror-image (27a), results in a clash just after the initial syllable. Stress occurs on the peninitial syllable and every even-numbered syllable from the right following the peninitial syllable. The pattern is unattested.

(27) a. Trochaic: *Unattested*

```
  x x   x
σ σ σ σ σ σ

x   x   x
σ σ σ σ σ σ σ
```

b. Iambic: Attested

```
  x   x x
σ σ σ σ σ σ

x   x   x
σ σ σ σ σ σ σ
```

The asymmetrical formulation of NonFinality accounts for the asymmetrical attestation of the patterns in (27), as well. It can cause a final stress to shift leftward to create the pattern in (27b) as a variation on iambic minimal alternation, but it cannot cause an initial stress to shift rightward to create the pattern in (27a) as a variation on trochaic minimal alternation.

To see how the (27b) pattern arises in a Weak Bracketing approach, consider the tableau in (28). When NonFinality and MapGridmark dominate Heads-Right and *Clash, the final foot head is pushed leftward in even-parity forms, resulting in a clash between a stressed penult and antepenult.

(28)

σσσσσσ	Non-Fin	MapGM	*Clash	All-Hds-R
☞ w. σ σ σ σ σ σ (x x x)			1	7
a. σ σ σ σ σ σ (x x x)	W 1		L	L 6
b. σ σ σ σ σ σ (x x)		W 1	L	L 6

As the tableau in (29) demonstrates, the addition of NonFinality to the constraint set does not allow the grammar to produce the unattested trochaic mirror image in (27a). The trochaic version is harmonically bounded by trochaic minimal alternation.

(29)

σσσσσσ	Non-Fin	MapGM	*Clash	All-Hds-L
☞ w. σ σ σ σ σ σ (x x x)				6
1. σ σ σ σ σ σ (x x x)			W 1	W 7

10.3.2 Variations on maximal alternation due to final stresslessness

The patterns in the next group are also created by preventing a peripheral stress. In this case, however, the patterns are variations on maximal alternation. For ease of comparison, the maximal alternation patterns are repeated in (30).

(30) Maximal alternation

a. Trochaic

```
x   x   x
σ σ σ σ σ σ

x   x   x   x
σ σ σ σ σ σ σ
```

b. Iambic

```
    x   x   x
  σ σ σ σ σ σ

x   x   x   x
σ σ σ σ σ σ σ
```

Deleting the final stress of the trochaic maximal alternation pattern yields the final lapse in the odd-parity form of (31a). Stress occurs on every odd-numbered syllable from the left except the final syllable. The pattern can be found in Pintupi (Hansen and Hansen 1969) and Wangkumara (McDonald and Wurm 1979).[8] Deleting the initial stress of the iambic minimal alternation pattern yields the initial lapse in the mirror-image (31b). Stress occurs on every odd-numbered syllable from the right, except the initial syllable. The pattern is unattested.

(31) a. Trochaic: Attested

```
x   x   x
σ σ σ σ σ σ

x   x   x
σ σ σ σ σ σ σ σ
```

b. Iambic: *Unattested*

```
    x   x   x
  σ σ σ σ σ σ

    x   x   x
σ σ σ σ σ σ σ
```

Consider how NonFinality's asymmetrical formulation helps the Weak Bracketing approach to produce the attested trochaic pattern in (31a) without also producing its unattested iambic mirror image. As (32) demonstrates, the (31a) pattern emerges in preference to trochaic maximal alternation when NonFinality, *Clash, and All-Heads-Right all dominate MapGridmark. Rather than retaining the final stress in odd-parity forms, or shifting the final stress to the left, the final foot is left stressless, resulting in a final lapse.

[8] Gordon (2002) lists twelve additional trochaic languages that have a final lapse in their odd-parity forms: Anguthimri, Badimaya, Bidyara/Gungabula, Dalabon, Dehu, Diyari, Karelian, Kate, Pitta Pitta, Tenango Otomi, Wirangu, and Yingkarta.

(32)

σσσσσσσσ	HD-L	ALL-HD-R	NON-FIN	*CLSH	MAPGM
☞ w. x x x σ σ σ σ σ σ σ σ	3	12			1
a. x x x x σ σ σ σ σ σ σ σ	3	12	W 1		L
b. x x x σ σ σ σ σ σ σ σ	3	W 13			L
c. x x x x σ σ σ σ σ σ σ σ	3	W 13		W 1	L

In contrast, NONFINALITY does not allow the Weak Bracketing approach to produce the unattested iambic mirror image. As (33) demonstrates, the iambic mirror image is harmonically bounded by iambic maximal alternation.

(33)

σσσσσσσσ	HD-R	ALL-HD-L	NON-FIN	*CLSH	MAPGM
☞ w. x x x x σ σ σ σ σ σ σ σ	3	12			
l. x x x σ σ σ σ σ σ σ σ	3	12			W 1

Rather than deleting a peripheral stress, the next pair of patterns is created by shifting a peripheral stress inward and deleting the adjacent stress to avoid clash. In (34a), the final stress of trochaic maximal alternation shifts to the penult and the stress of the antepenultimate deletes, resulting in a lapse just before the penult in the odd-parity form. Stress occurs, then, on the penult and every odd-numbered syllable from the left, except the antepenult. The pattern can be found in Piro (Matteson 1965) and Polish (Rubach and Booij 1985). In the iambic mirror-image (34b), the initial stress of iambic maximal alternation shifts to the peninitial syllable and the stress of the postpeninitial syllable deletes. Stress occurs on the peninitial syllable and every odd-numbered syllable from the right, except the postpeninitial syllable. The pattern is unattested.

(34) a. Trochaic: Attested

```
x   x   x
σ σ σ σ σ σ

x   x       x
σ σ σ σ σ σ σ
```

b. Iambic: *Unattested*

```
    x   x   x
σ σ σ σ σ σ

  x       x   x
σ σ σ σ σ σ σ
```

In the Weak Bracketing approach, the (34a) pattern emerges when NON-FINALITY, *CLASH, and MAPGRIDMARK all dominate HEADS-RIGHT. As (35) demonstrates, the final foot head is pushed leftward in odd-parity forms. Rather than tolerating a clash between a stressed penult and antepenult, however, the pattern employs a gridmark-sharing configuration to satisfy MAPGRIDMARK. It stresses the penult but leaves the antepenult stressless, resulting in a lapse.

(35)

σσσσσσσ	HD-L	NON-FIN	*CLSH	MAPGM	ALL-HD-R
☞ w. x x x σ σ σ σ σ σ σ	3				13
a. x x x x σ σ σ σ σ σ σ	3	W 1			L 12
b. x x x σ σ σ σ σ σ σ	3			W 1	L 12
c. x x x x σ σ σ σ σ σ σ	3		W 1		13

In contrast, NONFINALITY is unable to produce the unattested iambic mirror image. As (36) demonstrates, the iambic mirror image is harmonically bounded by iambic maximal alternation.

(36)

σσσσσσσ	HD-R	ALL-Hd-L	NON-FIN	*CLSH	MAPGM
☞ w. x x x x σ σ σ σ σ σ σ	3	12			
l. x x x σ σ σ σ σ σ σ	3	W 13			

10.3.3 Variations on minimal alternation due to initial stress

The final group of patterns can be thought of as variations on minimal alternation created by adding a peripheral stress. For convenience, the minimal alternation patterns are repeated in (37).

(37) Minimal alternation

a. Trochaic

```
  x   x   x
  σ σ σ σ σ σ

  x   x   x
σ σ σ σ σ σ σ
```

b. Iambic

```
  x   x   x
σ σ σ σ σ σ

  x   x   x
σ σ σ σ σ σ σ
```

Adding an initial stress to trochaic minimal alternation results in a clash at the left edge of the odd-parity form in the trochaic pattern in (38a). Stress occurs on the initial syllable and every even-numbered syllable from the right. The pattern can be found in Biangai (Dubert and Dubert 1973), Maithili (Jha 1940–1944, 1958), Passamaquoddy (LeSourd 1993), and South Conchucos Quechua (Hintz 2006). Adding a final stress to iambic minimal alternation results in a clash at the right edge in the iambic mirror image in (38b). Stress occurs on the final syllable and every even-numbered syllable from the left. The pattern is unattested.[9]

(38) a. Trochaic: Attested

```
  x   x   x
  σ σ σ σ σ σ

x x   x   x
σ σ σ σ σ σ σ
```

b. Iambic: *Unattested*

```
  x   x   x
σ σ σ σ σ σ

  x   x   x x
σ σ σ σ σ σ σ
```

The asymmetrical formulation of Initial Stress helps to account for the asymmetrical attestation of the patterns in (38). By insisting on an initial stress, the constraint can create a clash at the left edge as a variation on trochaic minimal alternation. Because it cannot insist on a final stress, however, it cannot create a clash at the right edge as a variation on iambic minimal alternation.

As (39) illustrates, when Initial Stress, MapGridmark, and Heads-Left all dominate *Clash, the (38a) pattern is preferred to trochaic minimal alternation. The requirement that the initial syllable be stressed prevents the optimal

[9] As Alber (2005) observes, potential examples of the (38b) pattern are less than persuasive. Gordon (2002) cites the iambic Central Alaskan Yupik as a potential example of an iambic system with a final clash in odd-parity forms. According to Miyaoka (1985), however, the final accent is not a rhythmic stress; rather, it is a weaker boundary accent that arises only in specific phonological and morphological contexts. It has also been claimed, based on a pattern of vowel deletion, that the iambic Odawa (Kaye 1973; Piggott 1980) has final stress resulting in clash in odd-parity forms. However, final syllables are arguably always heavy in Odawa. Also, deletion could fail in final position for a number of reasons unrelated to stress. It might fail, for example, because it would create undesirable consonant clusters.

form from taking advantage of a gridmark-sharing configuration to avoid clash. The initial and peninitial syllables must both be stressed in order to satisfy INITIAL STRESS and MAPGRIDMARK simultaneously, resulting in a clash at the left edge.

(39)

σσσσσσσσ	INIT STRESS	MAPGM	ALL-HDS-L	*CLASH
☞ w. x x x x σ σ σ σ σ σ σ			9	1
a. x x x σ σ σ σ σ σ σ	W 1		9	L
b. x x x σ σ σ σ σ σ σ		W 1	9	L

While the addition of INITIAL STRESS to the constraint set allows the Weak Bracketing approach to produce the attested trochaic pattern in (38a), it does not allow it to produce the unattested iambic mirror image in (38b). The iambic pattern remains harmonically bounded by iambic minimal alternation.

(40)

σσσσσσσσ	INIT STRESS	MAPGM	ALL-HDS-R	*CLASH
☞ w. x x x σ σ σ σ σ σ σ	1		9	
l. x x x x σ σ σ σ σ σ σ	1		9	W 1

The next pair of patterns is created in much the same way. Adding an initial stress to trochaic minimal alternation creates a new trochaic pattern, and adding a final stress to iambic minimal alternation creates a new iambic mirror image. In this case, however, the clash that is created by adding a peripheral stress to minimal alternation patterns is resolved by deleting the adjacent stress. This results in a lapse configuration next to the peripheral stress. In the trochaic pattern (41a), stress occurs on the initial syllable and every even-numbered syllable from the right, except the peninitial syllable, resulting in a lapse adjacent to the initial stress. The pattern can be found in Garawa (Furby 1974), Spanish

(Harris 1983), Norwegian (Lorentz 1996), and Indonesian (Cohn 1989). In the iambic mirror-image (41b), stress occurs on the final syllable and every even-numbered syllable from the left, except the penult, resulting in a lapse next to the final stress. The pattern is unattested.

(41) a. Trochaic: Attested b. Iambic: *Unattested*

```
  x   x   x          x   x   x
  σ σ σ σ σ σ        σ σ σ σ σ σ
x     x   x          x   x     x
σ σ σ σ σ σ σ        σ σ σ σ σ σ σ
```

As (42) illustrates, under a ranking where INITIAL STRESS, *CLASH, and HEADS-LEFT all dominate MAPGRIDMARK, the (41a) pattern is preferred to trochaic minimal alternation. Rather than tolerating a clash at the left edge to accommodate initial stress, the second foot is left stressless, resulting in a lapse.

(42)

σσσσσσσ	INIT STRESS	*CLASH	ALL-HDS-L	MAPGM
☞ w. x x x / σ σ σ σ σ σ σ			9	1
a. x x x x / σ σ σ σ σ σ σ		W 1	9	L
b. x x x / σ σ σ σ σ σ σ	W 1		9	L

INITIAL STRESS, however, does not allow the grammar to produce the unattested iambic mirror image in (41b). The iambic pattern remains harmonically bounded by iambic minimal alternation.

(43)

σσσσσσσ	INIT STRESS	MAPGM	ALL-HDS-R	*CLASH
☞ w. x x x / σ σ σ σ σ σ σ	1		9	
l. x x x / σ σ σ σ σ σ σ	1	W 1	9	

10.3.4 Interim summary

To this point, then, we have found substantial support for the generalizations in (8), repeated in (44). There are only four possible patterns with perfect alternation, patterns that contain neither clash nor lapse. In section 10.2, we saw that they form two mirror-image pairs and that both members of each pair are attested, as suggested in (8/44a). In section 10.3, we saw that mirror-image patterns that depart from perfect alternation, patterns that do contain a clash or a lapse, are asymmetrically attested, as suggested in (8/44b). We have also seen that clash and lapse in attested departures from perfect alternation occur in positions where they help to accommodate an initial stressed syllable or final stressless syllable, as suggested in (8/44c).

(44)
a. In mirror image patterns with neither clash nor lapse, both members of the pair are attested.
b. In mirror image patterns with either clash or lapse, at most one member of the pair is attested.
c. Attested patterns with clash or lapse always have stress on the initial syllable, always leave the final syllable stressless, or both.

To demonstrate that these generalizations can be captured by a foot-based approach, we also considered how the Weak Bracketing account of Hyde (2002) produces the appropriate patterns. In the Weak Bracketing account, the symmetrical alignment constraints on their own can produce only the four perfect alternation patterns. The account relies on the asymmetrical INITIAL STRESS and NONFINALITY constraints to introduce clash and lapse in the positions appropriate for the additional attested patterns. They cannot introduce clash and lapse, however, in the positions necessary to produce the unattested mirror images.

10.4 Goshiute Shoshone and Tauya

While we have found support for the generalizations in (8/44), and we have seen how these generalizations can be captured in a Weak Bracketing approach, the stress patterns of Goshiute Shoshone (Miller 1996) and Tauya (McDonald 1990) offer a potential counterexample to (8/44b, c). The trochaic Goshiute Shoshone has been reported to have clash at the right edge in even-parity forms and the iambic mirror image, Tauya, to have clash at the left edge (Kager 2001; Gordon 2002).

(45)
a. Goshiute Shoshone?

```
x   x   x x
σ σ σ σ σ σ
x   x   x   x
σ σ σ σ σ σ σ
```

b. Tauya?

```
  x x   x   x
  σ σ σ σ σ σ
x   x   x   x
σ σ σ σ σ σ σ
```

If the reports are accurate, the mirror-image pair in (45) supports an approach where the constraint requiring peripheral stress is symmetrical, as in (46), rather than asymmetrical, as in the INITIAL STRESS formulation.

(46) STRESS EDGES: The initial syllable and final syllable of the prosodic word are stressed.

As Gordon (2002) demonstrates, patterns like those discussed in section 10.3.3 – patterns that require initial stress, rather than stress on both edges – can be captured by ranking NONFINALITY over STRESS EDGES. Patterns like those in (45), which require stress at both edges in order to create a clash in even-parity forms, can be captured by ranking STRESS EDGES above NONFINALITY.

The problem with such an analysis is that it also produces patterns that are clearly unattested. If STRESS EDGES can be satisfied by tolerating a clash in even-parity forms, it can also be satisfied by tolerating a lapse, resulting in the unattested mirror-image pair in (47).

(47) a. Trochaic: *Unattested*

```
x   x     x
σ σ σ σ σ σ

x   x   x   x
σ σ σ σ σ σ σ
```

b. Iambic: *Unattested*

```
x     x     x
  σ σ σ σ σ σ

x   x   x   x
σ σ σ σ σ σ σ
```

Apart from these problematic predictions, there is good reason for giving the original descriptions of the patterns in (45) a closer examination. The attested stress patterns discussed in previous sections are all represented in multiple languages, and their existence is relatively well established. In contrast, Goshiute Shoshone is the only known potential example of the pattern in (45a), and Tauya is the only known potential example of the pattern in (45b). As we shall see, there is ample evidence to suggest that Goshiute Shoshone and Tauya exhibit the trochaic and iambic maximal alternation patterns, respectively, rather than the patterns with clash, suggesting that the STRESS EDGES analysis and its problematic predictions may not be necessary.

(48) a. Goshiute Shoshone

```
x   x   x
σ σ σ σ σ σ

x   x   x   x
σ σ σ σ σ σ σ
```

b. Tauya

```
    x   x   x
  σ σ σ σ σ σ

x   x   x   x
σ σ σ σ σ σ σ
```

From Miller's (1996) description of Goshiute Shoshone, for example, it is clear that there are significant restrictions on final stress. Final syllables are only stressed when they contain a voiced vowel (p. 698), and final syllables with voiced vowels appear always to be heavy. In final syllables, voiced vowels are usually followed by a glottal stop plus a voiceless echo vowel (p. 697), the

additional length / segmental content likely corresponding to greater weight. The presence of the final stress necessary to produce clash in even-parity forms, then, depends on the final syllable being heavy. When the final syllable is light, the trochaic minimal alternation pattern emerges. Since this is the pattern that occurs with light syllables, trochaic minimal alternation appears to be the default.

McDonald (1990) actually provides two descriptions of the Tauya stress pattern, both of which are supported by a pattern of vowel reduction. In the first, McDonald (p. 52) indicates that initial syllables are stressless in even-parity forms but that they fail to reduce just like stressed syllables.

> Stress in Tauya is by and large predictable: primary stress falls on the final syllable in a word, with secondary stress on preceding alternate syllables. A single unstressed vowel is optionally reduced to [ə] if it is non-initial, i.e. if it is preceded and followed by stressed syllables.

In the second description, McDonald (p. 84) interprets the absence of vowel reduction in initial syllables as evidence that they are always stressed, even in even-parity forms where they would participate in a clash.

> Stress in Tauya is by and large predictable: primary stress falls on the final syllable in a word, with secondary stress on preceding alternate syllables. The initial syllable in a word is never without stress; if a word is polysyllabic, the initial syllable always receives secondary stress, even if this results in adjacent stressed syllables.

Since greater resistance to vowel reduction in initial syllables is expected independently of stress (Beckman 1998), however, the case for initial stress in Tauya is not particularly strong. It is likely that Tauya is simply an example of iambic minimal alternation rather than the initial clash pattern in (45b). Vowel reduction fails to occur in initial syllables, because they are initial (and, thus, independently prominent), not because they are stressed.

Since the Weak Bracketing account sketched above has two constraints, Head-Left and Head-Right, that have the effect in certain contexts of anchoring a single head syllable at either edge of the word, it is interesting to note that the approach can produce neither the patterns with clash in (45) nor the patterns with lapse in (47). The reasons have as much to do with the particular formulation of alignment constraints employed here, however, as they do with the structural assumptions of Weak Bracketing. Since Head-Left and Head-Right assess a violation mark for every misaligned head syllable, a candidate can never improve its performance by inserting a gratuitous head syllable at the relevant edge. Since even-parity forms that have head syllables at both edges necessarily have more head syllables under Weak Bracketing assumptions than even-parity forms that only have a head syllable at one edge, the combination of Head-Left and Head-Right cannot actually require head syllables at both

edges.[10] As (49) demonstrates, the patterns in (45) and (47) are harmonically bounded by trochaic maximal alternation under the Weak Bracketing approach.

(49)

σσσσσσ	HD-L	HD-R	HDS-L	HDS-R	MPGM	INTGM	*CLSH
☞ w. x x x σ σ σ σ σ σ	2	3	6	9			
a. x x x x σ σ σ σ σ σ	W 3	3	W 11	9			W 1
b. x x x σ σ σ σ σ σ	W 3	3	W 11	9	W 1		
c. x x x x σ σ σ σ σ σ	W 3	3	W 9	W 11			W 1
d. x x x σ σ σ σ σ σ	W 3	3	W 9	W 11	W 1		

10.5 Summary and conclusion

In this chapter, we have examined the generalizations that emerge when we use mirror-image pairs to compare metrically similar patterns. In sections 10.2 and 10.3, we found support for the following three generalizations. First, in mirror-image pairs with perfect alternation, trochaic patterns and their iambic mirror images are both attested. Second, in mirror-image pairs that depart from perfect alternation, either the trochaic version is attested or the iambic version but not both. Third, in attested patterns that depart from perfect alternation, the clash or lapse configuration arises to accommodate either an initial stressed syllable or a final stressless syllable. We also saw how these generalizations are captured in the foot-based Weak Bracketing account (Hyde 2002) employing the INITIAL STRESS and NONFINALITY constraints.

In section 10.4, we examined a mirror-image pair that seems to constitute a counterexample to the second and third generalizations mentioned above. Goshiute Shoshone has been claimed in the secondary literature to be an

[10] The Weak Bracketing approach assumes the non-violable HeadGap Condition, which prohibits head syllables from occurring more than one syllable apart. See Hyde 2002 for discussion.

example of a basically trochaic language with clash at the right edge in even-parity forms. The iambic mirror-image Tauya has been claimed to have clash at the left edge in even-parity forms. If the descriptions are accurate, the Goshiute Shoshone–Tauya pair would constitute a case of a departure from perfect alternation where both the iambic and trochaic versions are attested, and Goshiute Shoshone would constitute a case where clash is introduced to accommodate a final stress.

In examining the original descriptions of Goshiute Shoshone (Miller 1996) and Tauya (McDonald 1990), however, it becomes apparent that a strong case can be made that Goshiute Shoshone and Tauya do not really tolerate clash configurations, at least not in their basic patterns, and that they are really just cases of minimal alternation. Goshiute Shoshone and Tauya, then, do not present clear counterexamples to the generalizations discussed above.

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11 Representing rhythm

Harry van der Hulst

11.1 Introduction

In many so-called 'stress languages', the rhythmic profile of words results from two *separate* procedures: accent and rhythm.[1] The accentual module selects a specific syllable which occupies the position of primary stress and which functions as an important reference point for rhythm. In van der Hulst (2009, 2011a, 2012, in prep. a) it is argued that the burden of irregularity is carried by the accentual module which belongs to the *lexical phonology*. Subsequently, a rhythmic module provides the complete rhythmic 'wordscape'. I will argue that rhythm is typically (and perhaps always) post-grammatical (not just post-lexical, but also post-syntactic) and as such fully regular.[2] In addition to accent and alternating rhythm, I will adopt a third 'player' in the rhythmic structure, namely a 'polar beat' that provides prominence to the edge opposite to the edge of the lexical accent.

This chapter starts, in section 11.2, with a comparison between 'classical metrical theory' and the 'separation theory'. I will show that the latter theory involves a deconstruction of metrical theory into three components: accent assignment, rhythm assignment,[3] and constituency. With reference to the role of constituency, I adopt the point of view that such structure, if needed, is assigned with reference to the complete rhythmic wordscape.[4] However, in this chapter, constituent structure is not discussed. I then provide a brief overview of the accentual module (based on van der Hulst 2012) in section 11.3, after which this chapter focuses on the rhythmic module, which is presented in terms of a grid-only approach (Prince 1983; Gordon 2002). I provide a typology of rhythmic systems, based on various discussions in the literature and the available evidence from the StressTyp database (Goedemans and van der Hulst 2009, this volume).

[1] I wish to thank two anonymous reviewers for comments, as well as Beata Moskal, Matt Gordon, and Rob Goedemans for their comments on an earlier version of this chapter.

[2] In van der Hulst (2011c, in prep. b) I discuss the need for different levels in phonology.

[3] Here I take the polar beat to be part of the rhythmic module and discuss this point in section 11.4.4.

[4] See Vaysman (2009) for a similar view.

A distinction is made between *simple rhythms* and *complex rhythms*, the latter mostly involving so-called *bidirectional systems* or *dual systems*. The proposal is made here that bidirectionality is a consequence of an *Edge Prominence rule* which places a polar beat on the edge opposite to the accent that underlies the primary stress, creating a 'hammock pattern'. Subsequently, rhythm operates in the valley between these two prominence peaks and can echo (i.e. ripple away from) either one or the other. I also discuss a subclass of the complex rhythms occurring in so-called *clash systems*, proposing that these systems too can be seen as having two opposite prominence peaks with rhythm bouncing into the lesser, polar beat.

For the specifics of rhythm assignment I compare three alternative theories, concluding that the simplest theory, one that has no iambic or trochaic bias but instead operates with 'free beat addition', is sufficient and thus preferred. Overall, I propose the following set of rhythm parameters.

(1) Rhythm parameters
   a. Polar beat (y/n)
   b. Rhythm (polar/echo)[5]
   c. Weight (y/n)
   d. Lapse (y/n)
   e. NonFinality (y/n)

I included here the polar beat under the rhythm parameters, although the point will be argued that this kind of 'Edge Prominence' is an independent submodule in the post-lexical phonology, *preceding* alternating rhythm. Parameter (b) indicates whether rhythm is echoing the lexical accent or, if present, the polar beat. Parameter (c) decides whether rhythm is weight-sensitive and parameter (d) decides whether rhythm is binary or ternary. Parameter (e) decides whether the final syllable is provided with a rhythmic beat or not. I will show that these parameters explain the variety of attested rhythmic patterns, including the symmetries and asymmetries that have been attested in the literature (see in particular Hyde, this volume, who adopts an Optimality Theoretic model, which I do not).

Needless to say that the model proposed here is based on rather limited and often controversial understanding of rhythmic patterns in natural languages.[6] It is well known that there are numerous difficulties with current descriptions,

[5] Since polar rhythm is here analyzed as rhythm that ripples away from a polar beat, both polar and echo rhythm are of the echoing type. Nonetheless, I will here preserve the terms 'polar rhythm' and 'echo rhythm' as shorthand, the former referring to a system in which rhythm echoes the polar beat and the latter for systems in which rhythm echoes the accent.

[6] For a recent overview of work on linguistic rhythm and for new findings regarding the role of duration and F0, see Cummings (2010).

which are due to a variety of factors such as (see van der Hulst, this volume, chapter 1; de Lacy, this volume; and Hualde and Nadeu, this volume):

- the lack of clear acoustic or articulatory properties of rhythmically strong syllables
- the status of rhythm as a cognitive mechanism of grouping
- (as a consequence) the difficulty in providing reliable instrumental or impressionistic reports on the location of rhythmic beats
- the rhythm bias of non-native speaker analysts
- the implicit decision to neglect reporting on rhythmic beats
- the dependence of rhythm organization on speech tempo/style
- the dependency of rhythm of words on phrasal context
- (as a consequence) the variability of rhythmic beats
- the often unclear interaction between syllable weight and rhythm

With these factors at play, it may seem foolish to develop a model of rhythm assignment, but I nonetheless have to engage in this endeavor to make my approach to word stress comparable to other (specifically metrical) theories. Such theories typically offer holistic accounts of primary stress and non-primary stress, whereas I have claimed that these phenomena need to be separated. Having proposed a model for accent assignment (accounting for primary stress locations) in van der Hulst (2012), it was therefore necessary to also develop a rhythmic module which accounts for the kinds of data that other stress theories are currently based on. In this enterprise, I use the same kind of data that have fueled a sizeable volume of metrical literature which rather crucially relies on the assumption (while realizing the pitfalls) that the reported patterns are in principle correct until further notice.[7] My main objective has been to demonstrate that such a theory can be kept rather simple, essentially using 'free beat addition'.

11.2 Deconstructing metrical theory

Elsewhere[8] I have advocated an approach (the Accent First approach, AF) which introduces the role of accent in accounting for word stress systems. Stress systems come in a wide variety of types, both in terms of the location of primary stress and in terms of the presence of additional rhythmic structure. As a working definition, I take a *word*-stress system to be present when words, *independent from phrasal context*, have one specific syllable that is more

[7] Theorizing on the basis of data that is not ideal can be dangerous, but it also has a good side: it raises specific questions and desiderata that can be taken into account in subsequent descriptive and data-gathering work.

[8] In van der Hulst 1984, 1996, 1997, 1999, 2009, 2011a, 2012, in prep. a; Goedemans and van der Hulst, this volume.

prominent than all other syllables, with prominence being manifested in terms of a combination of phonetic exponents such as duration, greater intensity, hyperarticulation, etc.[9] In this chapter, the focus is on word-stress systems that display word-internal rhythm, i.e. prominence peaks in addition to but weaker than the primary stressed syllable. The central claim of the AF approach is that, in such stress languages, the overall *rhythmic profile* (including primary stress and non-primary stresses) of words can be seen as resulting from *two* separate procedures: accent assignment and rhythm assignment.[10] The former procedure effectively selects the syllable that will carry primary stress (in a word-stress system). In this view *stress* is regarded as a *phonetic realization* of accent, taking accent itself to be purely abstract in the sense of being void of phonetic content.

(2) [σσσσσ́σ]
↓
phonetic exponents

The situation in (2) would be sufficient for languages that are reported to have a (primary) stressed syllable and nothing else. If, in addition to accent (interpreted as stress) words have a rhythmic structure, i.e. display a pattern of strong and weak syllables and/or a polar beat, an additional layer of structure is required, which, like accent, I take to be structural and inherently non-phonetic. As the model for rhythmic structure assignment, I adopt (with some significant modifications) the theory of perfect gridding, proposed in Prince (1983). In this theory, syllables are lined up with a grid structure consisting of 'beats' (here represented by 'x') and non-beats (represented by the absence of 'x'). With accent already in place, I stipulate that rhythm must respect its location by making sure that the accent is lined up with a beat. Since accent and rhythm will be located in different modules of the phonology, I call this an *interface condition*:

(3) [σσσσσ́σ]
: : ⇑
x x x
↓ ↓ ↓
phonetic exponents

[9] Unlike Hyman (this volume), I maintain a distinction between stress-accent systems and pitch-accent systems. In the latter, accent is the anchor for quasi-tonal properties only. For discussion, I refer to van der Hulst (2011a, 2012).

[10] This leaves open the possibility that both accent and rhythm can function independently in each other's absence. Languages with accent realized as stress do not necessarily have an additional rhythmic pattern. On the other hand, there are languages that have no need for accent, while still having some sort of stress (e.g. Indonesian; Goedemans and van Zanten 2007), involving either boundary tones, Edge Prominence, and/or rhythm. See section 11.3.3 for some discussion of the latter situation.

In terms of phonetic exponents, accented syllables (having primary stress) are generally *more* prominent than syllables that are prominent in terms of rhythm only (having non-primary stresses). This is how accents exercise their demarcative function. If we wish the phonetic interpretation to be blind to accents, we would have to adopt the principle that the accented syllable, by convention, gets one more 'x' on the grid:

(4)

```
[σσσσσ́σ]
 :  :  ⇑
 x  x  x
       x
 ↓  ↓  ↓
phonetic exponents
```

This extra gridmark is fully determined by the accent location and not, as in Prince (1983), the result of an independent 'End Rule', although we could call this effect the result of the *accent-driven End Rule* and leave open for the moment whether the rhythmic grid can be enriched by End Rules that are *not* accent-driven.[11] However, for ease of graphic display in subsequent diagrams I will leave the extra gridmark out.

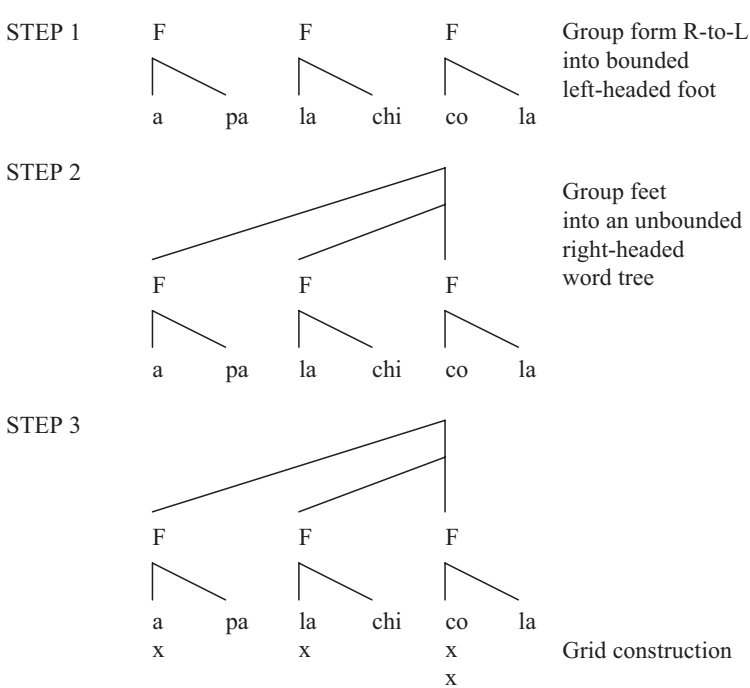
Classical metrical theory (Liberman and Prince 1977) proposed that, in addition to a grid structure, there is another structure, the metrical tree, a binary-branching constituent structure from which the grid is, in part, derived. To illustrate this, let us briefly review how stress patterns are derived in standard metrical theory. First, syllables of words are organized into headed feet. Second, primary stress is derived by organizing the feet into a *word structure* in which one foot is the head. The head of the head foot expresses primary stress. Subsequently, a grid structure is derived from the tree structure, projecting a gridmark for every head in the tree structure.[12]

In this view, then, rhythm (in the form of foot structure) is assigned first, while primary stress is regarded as the 'promotion' of one of these rhythmically strong syllables:

[11] At this point, the reader might think that the above-mentioned polar Edge Prominence rule can be regarded as an End Rule that applies to the grid. It must be born in mind, then, that the polar rule applies before rhythmification, and not to its result. In this respect, AF theory is making the claim that rhythm comes second twice: both the lexical accent and the polar rule take precedence over rhythm.

[12] Given that the word tree was taken to be binary branching, primary stressed syllables would end up with more 'x' marks than necessary, so the procedure was stated such that the height of grid columns was kept minimal.

(5)



One of the motives for having a grid structure *and* a tree structure was that, after grid projection, additional grid rules could be applied, such as, for example, a rule which would assign extra prominence to the first syllable, giving:

(6)

a	pa	la	chi	co	la	
x		x		x		
x				x		Initial beat addition
				x		

The original suggestion in Prince (1983) was to regard the grid not as being derived from a tree structure, but as basic. Prince, in fact, argued that the evidence for a tree organization was weak and that given the high overlap between trees and grids one must try to remove one from the theory, preferably the one with more (and thus unnecessary) information. For him the choice was to remove the trees. Kiparsky (1979), motivated by the same desire to eliminate redundancy, proposed to eliminate the grid, implicitly assuming that constituency is needed. This view entails the need for metrical transformations in order to get the trees to be proper reflections of the rhythmic organization (including the initial secondary stress in (6)), a tradition that was carried out

(up to and including the phrasal level) in Giegerich (1985). The question as to whether grouping of syllables into feet is or is not necessary continued to be raised. Kenstowicz (1993), for example, discusses processes that seem to crucially require foot structure. Halle and Vergnaud (1987), convinced by these arguments, and adding some of their own, develop the well-known hybrid version of metrical theory which used 'bracketed grids'.[13]

The AF theory differs from both standard metrical theory and Prince's grid theory in reversing the order in which primary stress (or rather, accent) and non-primary stress (i.e. rhythm) is assigned. This theory remains neutral with respect to the question as to whether syllables are grouped into feet. One possibility is that the assignment of rhythm forms the basis for footing, allowing us to derive (7) from (4):[14]

(7)
```
[σ σ  σ σ  σ́ σ]
(x .) (x .) (x .)
          x
↓ ↓  ↓ ↓  ↓
phonetic exponents
```

The AF theory is thus in several ways 'backwards' when compared to standard metrical theory:

(8)

a. Standard metrical theory	b. Accent First theory
i. Foot construction	i. Primary stress (accent assignment)
ii. Primary stress (word tree construction)	ii. Rhythm (grid construction)
iii. Rhythm (grid construction)	iii. Foot construction (adding constituency)

We can also depict the differences in the following Optimality Theoretic (OT) manner:

(9)
a. Standard metrical theory : Foot ≫ primary stress ≫ rhythm
b. Accent First theory : Primary stress ≫ rhythm ≫ foot

With the display in (9), we make explicit that the difference between the two theories can, from the perspective of OT (Prince and Smolensky 1993), be understood as following from differences in the ranking of (blocks of) constraints. Indeed, Prince and Smolensky, convinced by van der Hulst (1984) that at least in some cases primary stress seems to determine rhythm, use this as one argument for adopting a non-derivational theory, i.e. a theory that

[13] I take the bracketed grid to be equivalent to tree structure. This does not hold for the version developed by Idsardi (1992, 2009), which uses unmatched brackets.

[14] Vaysman (2009) also presents a model in which foot constituency is assigned on the basis of a grid structure.

evaluates structures rather than builds them. If we adopt the motto 'let there be structures' (the OT generator) and we have blocks of constraints that bear on various aspects of these structures, we can have primary stress constraints outrank rhythm constraints, and vice versa. And indeed, if foot constituency is seen as separate from rhythm, it is in principle possible that the manner in which these two are aligned can depend on the ranking of constraints as well. An OT approach, allowing for language-specific ranking, thus allows both (9a) and (9b), as well as other logically possible orderings.

Accent First theory does not adopt this OT perspective. At the time it was, and still is, my view that parochial ranking is too powerful a mechanism. Thus I take the ordering in (9b) to universally fixed, mostly in terms of how the various relevant components are ordered. The issue here, then, is not with 'using constraints'. Even though I use a parametric model, it must be realized that 'set parameters' (i.e. parameters whose value has been specified) *are* constraints.[15]

I now turn to a brief description of the accent module,[16] which is followed in section 11.4 by an extensive discussion of rhythm. In section 11.5, I present my main results and conclusions.

11.3 The accentual module

This section summarizes the proposal in van der Hulst (2012).

11.3.1 Bounded systems

In many stress languages, primary stress falls on a syllable near the edge of the word (initial, second syllable, third syllable, antepenultimate, penultimate, ultimate):[17]

(10) Possible accent locations in bounded systems

Left			*Right*		
Initial	*Second*	*Third*	*Antepenultimate*	*Penultimate*	*Ultimate*
Czech, Finnish	Dakota	Winnebago	Macedonian	Polish	Turkish, French

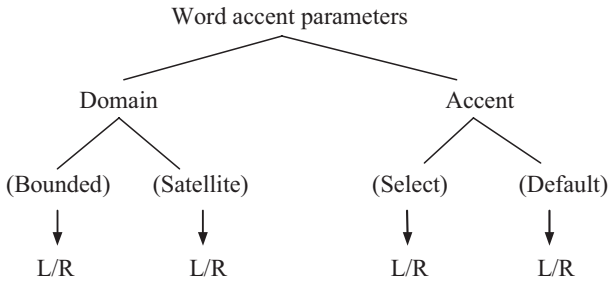
[15] An independent issue is whether, next to constraints, we employ rules which remove constraint violations when the grammar has combined morphemes into words and words into sentences.

[16] A more extensive discussion can be found in van der Hulst (2009, 2012, in prep. a).

[17] These characterizations of stress/accent locations are based on StressTyp, a database for word stress/accent systems of the languages of the world; cf. Goedemans and van der Hulst (2009), van der Hulst (this volume, chapter 1). Except for some cases that are discussed in more detail, I did not include references for the languages mentioned here and below which can all be found in the database that is available online: www.unileiden.net/stresstyp/.

In my approach, systems of this sort set a *domain* limitation on accent and then determine the location of accent *within* this domain. To this end, I adopt the following parameters:

(11)



We also need mechanisms that determine accents in the first place. I will assume that accents are either due to syllable weight (in weight-sensitive languages) or are lexically marked on syllables (in so-called 'lexical accent systems').

I will clarify how each of these parameters delivers a relevant distinction:

(12) Explanation of parameters

a. Bounded = form a bisyllabic domain: on the left or right side of the word
b. Satellite = 'add' one syllable: to the left or right of the domain (whether bounded or unbounded)
c. Select = select the leftmost or rightmost accent in the domain
d. Default = if no accent mark is present in the domain: assign accent to the leftmost or rightmost syllable

The first parameter (Bounded) allows us to distinguish between bounded and unbounded accentual domains. If the domain parameter is *not* active, the domain equals the whole word, which leads to an unbounded system; the option of inactivity is indicated in (11) by the parentheses around parameters. If, however, this parameter is active, we must choose an edge for the domain. Bounded(L) gives us a left-edge accent (first or second syllable, depending on parameters Select and Default), while Bounded(R) gives us a right-edge system (final or penultimate, again dependent on Select and Default).

The parameter Satellite (if active) tells us that there is a syllable to the left or right of the domain. This allows the formation of trisyllabic domains (if the satellite is *internal*) or Extrametricality (if the satellite is *external*, i.e. adjacent

to the word edge). These two options are illustrated in (13) for a right-edge bounded domain (domain *plus* satellite are here between curly brackets):

(13) a. Bounded(R); Satellite(R):
. . . σ {(σ σ)+σ}] (external satellite, invisible for accent)
b. Bounded(R); Satellite(L):
. . . σ {σ+(σ σ)}] (internal satellite, visible for accent)

The Select parameter is necessary because a domain can contain more than one accented syllable, at most two if the domain is bounded (ignoring the satellite option), but more if the domain is unbounded, Select will bring *resolution* by designating the leftmost or the rightmost accent as the 'winning' accent within the domain, which implies, by convention, that all others are deleted.[18] Finally, if the domain contains no accent at all, Default assigns an accent to the leftmost or rightmost syllable in the domain. In section 11.3.4 I explain why these two parameters can also be inactive.

To derive, for instance, the primary accent pattern of Czech, which has initial stress, we need to place a *bounded domain* on the left side and set Default for 'left':[19]

(14) Initial accent
(x .)
[σ σ σ σ σ

Antepenultimate accent in Macedonian can be derived by locating a bounded domain on the right edge of the word which, due a satellite, 'skips' the final syllable, setting Default at 'left':

(15) Antepenultimate accent
{ (x .) .}
σ σ σ σ]

By adopting the bisyllabic domain and by allowing 'skipping' of one peripheral syllable on the edge, we account for the restricted edge location of fixed accents in bounded systems. Thus far, my approach is not very different from one which would assign a weight-insensitive non-iterative foot. To see that what is needed for accent location cannot be accommodated by any variety of foot typology that has been proposed we have to turn to weight-sensitive systems.[20]

[18] Instead of deleting the 'losers', one could also instead promote the winner (with an extra gridmark). The proper treatment of resolution depends on whether losers can be phonetically cued or play a role in accent-sensitive rules. I discuss these issues in van der Hulst (in prep. a).

[19] Many weight-insensitive languages can, at first sight, be analyzed as either bounded or unbounded. As shown in van der Hulst (2012), a decision can often be made on the basis of the kinds of exception that the system permits. See Gussenhoven (this volume) for the treatment of exceptions in an OT approach.

[20] See van der Hulst (2000) for a detailed discussion and comparison of foot theories.

In so-called *weight-sensitive* languages the accent is not fixed on a particular syllable in the word, but neither does the accent rule randomly target just any syllable. As shown in van der Hulst (2009, 2012, in prep a.), within a bisyllabic domain (and ignoring the option of a satellite here) there are *four* logical options for right-edge weight-sensitive systems (here bold sigmas represent heavy syllables; each heavy syllable projects an accent mark if a system is weight-sensitive):

(16) Right-edge weight-sensitive systems

	x	x	~~x~~ x	x	
i.	a. (**σ** σ)]	b. (σ **σ**)]	c. (**σ** **σ**)] Sel: right	d. (σ σ)] Def: left	e.g. Epena Pedee
	x	x	~~x~~ x	x	
ii.	a. (**σ** σ)]	b. (σ **σ**)]	c. (**σ** **σ**)] Sel: right	d. (σ σ)] Def: right	e.g. Yapese
	x	x	x ~~x~~	x	
iii.	a. (**σ** σ)]	b. (σ **σ**)]	c. (**σ** **σ**)] Sel: left	d. (σ σ)] Def: left	e.g. Sunda
	x	x	x ~~x~~	x	
iv.	a. (**σ** σ)]	b. (σ **σ**)]	c. (**σ** **σ**)] Sel: left	d. (σ σ)] Def: right	e.g. Aklan

We also find four patterns on the left edge:

(17) Left-edge weight-sensitive systems

	x	x	~~x~~ x	x	
i.	a. [(**σ** σ)	b. [(σ **σ**)	c. [(**σ** **σ**) Sel: right	d. [(σ σ) Def: left	e.g. Capanahua
	x	x	~~x~~ x	x	
ii.	a. [(**σ** σ)	b. [(σ **σ**)	c. [(**σ** **σ**) Sel: right	d. [(σ σ) Def: right	e.g. Archi
	x	x	x ~~x~~	x	
iii.	a. [(**σ** σ)	b. [(σ **σ**)	c. [(**σ** **σ**) Sel: left	d. [(σ σ) Def: left	e.g. Malayalam
	x	x	x ~~x~~	x	
iv.	a. [(**σ** σ)	b. [(σ **σ**)	c. [(**σ** **σ**) Sel: left	d. [(σ σ) Def: right	e.g. Ossetic

If the domain contains only one heavy syllable, as in the first two columns, it will always be accented; both Select and Default are not relevant in this case. Column (c), which shows the case of two heavy syllables, and thus two accents if weight-to-accent is 'on', shows the need for an edge choice for Select, while column (d), in which the domain contains no accent at all, shows that the setting of Default is independent of the setting of Select, yielding four different

systems. Thus, if one syllable is heavy and the other is light, accent always falls on the heavy syllable. When syllables are equal in weight, four possibilities arise. The four-way distinction that we find at each edge cannot be accounted for in any of the foot typologies that have been developed in standard varieties of metrical theory. At least, no inventory of feet has ever been proposed that can account for this diversity without additional corrective machinery such as movement or deletion rules (as used, for example, in Halle and Vergnaud 1987 and Hayes 1995).

Interesting confirmation for the approach taken here can be drawn from the class of weight-sensitive unbounded accentual systems.

11.3.2 Unbounded systems and their theoretical consequences

Thus far we have assumed that the domain in which accent is assigned is bisyllabic. We also have to reckon with a class of cases in which the location of accent does not seem to be restricted to a bisyllabic window on either side of the word. In this class of systems, the accent may occur *anywhere in the word* (modulo Extrametricality). We can only clearly detect unboundedness in a weight-sensitive system (or in so-called 'unbounded lexical accent systems';[21] see footnote 19). The rules typically favor either the first or the last *heavy syllable* in the word, placing primary accent at either the left or right edge in the absence of heavy syllables. Thus, we derive the four possible unbounded accent types:

(18) Four types of weight-sensitive unbounded systems
  a. Accent the last heavy, or else the first light syllable; e.g. Sikaritai.
  b. Accent the last heavy, or else the last light syllable; e.g. Puluwatese.
  c. Accent the first heavy, or else the last light syllable; e.g. Tahitian.
  d. Accent the first heavy, or else the first light syllable; e.g. Amele.

All four patterns are attested in the languages of the world (also see Hayes 1995: 296–9). Recall that the four-way distinction is possible because both Select and Default have two values which can be chosen independently:

(19) LAST/FIRST

Sel: right	~~x~~ x	Def: left	x
	σσ **σ** σ **σ** σ σ σ		<u>σ</u> σ σ σ σ σ

[21] In such systems, accents, instead of being projected from heavy syllables, are lexically marked on vowels of morphemes. It may then happen that a morphologically complex word contains either multiple accents or no accent at all. See Revithiadou (1999) for extensive coverage of such systems.

LAST/LAST

Sel: right	~~x~~ x	Def: right	x
	σ σ **σ** σ **σ** σ σ σ		σ σ σ σ σ σ̲

FIRST/LAST

Sel: left	x ~~x~~	Def: right	x
	σ σ **σ** σ **σ** σ σ σ		σ σ σ σ σ σ̲

FIRST/FIRST

Sel: left	x ~~x~~	Def: left	x
	σ σ **σ** σ **σ** σ σ σ		σ̲ σ σ σ σ σ

The only difference between the unbounded systems and the bounded systems in (16–17) and (19) is the size of the accentual domain.

At this point, the accent theory is no longer comparable to a non-iterative binary foot approach, which reveals that the resemblance of the bounded accent domain to a foot is only apparent. Unbounded systems have always been problematic for metrical theory and in the end the majority view was to reject unbounded foot types, thus restricting the scope of metrical theory to bounded systems (Hayes 1995). However, such a strict separation of bounded and unbounded systems is not necessary if, as I have proposed here, we simply adopt the choice of domain (bounded or unbounded) as a basic parameter.[22]

In conclusion, it would seem that primary stress in both bounded and unbounded systems is non-metrical (cf. van der Hulst 1997). I thus modify Hayes's (1995, section 3.2.2) idea that 'stress is rhythm' into 'stress is accent' (as well as many other things; see van der Hulst 2012), although, as mentioned, some stress systems have additional rhythmic structure. Bounded accent locations might very well be diachronically grounded in rhythm, but it is also likely that word demarcation as such is what motivates such systems, with deviations from the first or last syllable deriving from the effects of syllable weight and intonation (see Gordon, this volume). From a cognitive–computational point of view, accent is autonomous, independent, *and different* from rhythm.

[22] In early versions of metrical theory (Vergnaud and Halle 1978; Hayes 1981), the parallelism between bounded and unbounded systems was captured by recognizing bounded and unbounded feet. The theory proposed here shares more with that version, although the use of unbounded feet was problematic for various reasons. Unbounded feet (of which there can be several in a word) are not identical to the unbounded accent domain (of which there can be only one); see van der Hulst (in prep. a) for detailed discussion. The theories proposed in Halle and Vergnaud (1987) and Idsardi (1992, 2009) continue to cover both bounded and unbounded systems in terms of bracketed grid structures. These theories are still different from the one presented here in that, as in all versions of metrical theory, primary stress is built on the basis of rhythm, rather than vice versa. Additionally, and granted that this theory builds constituency, it would seem that the model proposed here is much simpler, while accounting for the same array of stress systems.

11.3.3 Is accent universal?

I have proposed that all languages with a clear regular stress location (possibly dependent on syllable weight) that is determined at the word level and independent from phrasal context should be analyzed as an accentual system. In many cases, perhaps all, we find that in languages with such systems, there are always words (sometimes few, sometimes many) that display an exceptional accent location. For example, Polish has rigid penultimate stress, but it also contains words with final and antepenultimate stress (Dogil 1999).

Accents also play a role in systems that have non-contrastive pitch manifestations, which, traditionally, are called pitch-accent systems (see van der Hulst 2011a, 2012, this volume, chapter 1). This two-fold function of accent raises the question whether accents can be present in still other languages where a peripheral syllable functions as the regular anchor for intonational tones, or where such syllables simply display a greater array of phonotactic (segmental or tonal) options than other syllables. If accents can thus have multiple exponents or correlates (see also van der Hulst, this volume, chapter 1), it could be that many more languages have accents than one might think if one only considers stress systems.[23]

Still, we must allow words to be unaccented either in addition to accented words (as in Tokyo Japanese) or in the language as a whole. In the latter case of a non-accentual language, it is possible that the language is being described as having stress that is 'fully automatic' (in which case, however, the location of stress is sometimes hard to pin down; see Goedemans and van Zanten 2007 for the case of Indonesian). It is tempting to hypothesize that in such cases the perceived stress is the result of the post-lexical Edge Prominence rule or a so-called 'boundary tone'. Languages without accent can of course also be only rhythmic (possibly weight-sensitive) since, like Edge Prominence, rhythmic alternation is independent from accent, even though it will interact with accent when present (the interface condition).[24] Finally, a non-accentual language can combine rhythm *and* Edge Prominence and this then gives the appearance of a stress-accent system and therefore could be analyzed as such. I conjecture that such systems are vulnerable to developing exceptions, in which case they definitely transition into the lexical accentual realm. The fourth logical possibility would be that a non-accentual language has neither Edge Prominence nor rhythm, which would yield a completely non-rhythmic

[23] See Hyman (this volume) for a critical discussion of the notion 'accent'.

[24] Such cases may give rise to languages described as having no multiple equal stresses. In van der Hulst (1997) I suggest that rhythm-only languages may give rise to so-called *count systems*, when the last rhythmic beat triggers association of intonational pitch which is then perceived as 'word stress'. Note that rhythm that does not ripple away from accent or polar beats, if both are missing, would have to be specified for its direction and its trochaic or iambic nature. This is a matter for further research.

language.[25] The logical possibilities for non-accentual languages are summarized in (24).

11.3.4 Why stress-accent languages do not have unaccented words

In van der Hulst (2011a, 2012) I show that, unlike stress, accent is neither necessarily obligatory nor necessarily culminative. I have just mentioned that in pitch-accent languages such as Tokyo Japanese words can be unaccented, in which case Default is inactive. If we also allow accent to be non-culminative (due to the fact that Select is inactive), we allow languages in which words can have multiple equal accents. This option allows us to analyze languages with more than one high-pitch peak (or 'tone') per word to also be pitch-accent languages (rather than tone languages), as long as there is a contrast between H and L 'tone' only. It would seem, however, that in stress-accent languages, accent is always obligatory and culminative. In van der Hulst (2012) I suggest that this is caused by the fact that an obligatory and culminative accent qualifies as a 'head of the word' for which the optimal phonetic cue is precisely the package of phonetic properties that fall under the umbrella term *stress*; stress, understood as primary stress, being *inherently* culminative. An additional reason may be that in stress languages which are also rhythmic, unaccented words (if postulated under the principle of 'freedom of the base') would all be assigned a rhythmic pattern, most likely anchoring at the edge at which accented words have an accent. This would make it difficult for a language learner to avoid postulating the first beat of this rhythmic pattern as a default accent. In short, two factors conspire to make stress-accent languages with unaccented words very unlikely. The next question is whether stress-accent languages can have words with multiple accents. If words have multiple accents, there is no culminativity, which would thus militate against choosing stress as a phonetic correlate of accent. This being said, there are of course many languages which have been argued to have several stresses per word and 'no primary stress' (see Hayes 1995). In van der Hulst (1997) I have suggested two possible analyses for such cases which typically occur in languages that have polysynthetic morphologies allowing for rather long words. First, such languages may simply lack accent and only have utterance-level (possibly weight-sensitive) rhythm. Second, in such languages words may be divided into several separate prosodic domains each with their own stress most likely due to Edge Prominence.

[25] Such a language might be tonal, but it should be clear that the properties of stress-accent, rhythm, and tone are not mutually exclusive; see van der Hulst (2011a) and Hyman (this volume).

11.4 The rhythm module

11.4.1 Systems without rhythm (but with the option of weight)

We established earlier that rhythmic alternation is *not* reported for all languages that have accent. On the assumption that this can mean that there really is no rhythmic structure (rather than this just not being mentioned by the linguist describing the language), we must say that the presence of rhythm is parametric. This leads to weight-insensitive languages that have a primary stress and nothing else.

Of course, a language can also be non-rhythmic and still be 'weight-sensitive', as exemplified by the following examples:

(20) a. West Greenlandic Eskimo (Rischel 1974)
Primary accent is final
All heavy syllables are 'strong'

b. Waalubal Bandjalang (Crowley 1978)
Primary accent is initial
All heavy syllables are 'strong'

Note that in these systems primary accent is weight-insensitive because it is invariably fixed. There being no rhythm, it would seem that the heavy syllables are salient simply because they are heavy and not because they attract a rhythmic beat.

11.4.2 Three types of rhythm

In this section, I propose a theory of linguistic rhythm which, unlike standard metrical theory, is not responsible for determining the location of primary stress. The primary stress location is based on the accent, which is determined by a separate module, the accent module, which has been briefly discussed in the previous section. In the present section, then, I will assume that the accent is in place (at least in accentual languages). I postulate that the rhythm *must* be sensitive to ('faithful to') word accent, if present, and *can* be sensitive to syllable weight. Kager (1992) wonders whether, if a language has syllables of different complexity, rhythm is not very likely to be sensitive to it. I sympathize with the spirit of this suggestion. It would be all right for a lexical rule (like the accent rule) to ignore complexity in a syllable, because grammatical rules are 'abstract'; they have been detached from their natural, phonetic grounding, and they may thus reflect this grounding only partially. One might argue that rhythmic rules, applying at the post-grammatical utterance level, are more likely to be 'natural', and therefore more reluctant to ignore phonetic substance that is actually there. However, while utterance rules are much closer to their

natural base than grammatical rules, they still reflect a certain level of language-specific conventionalization.[26] Hence, I will assume that rhythm rules *can* ignore weight, even if languages have a vowel length distinction or open and closed syllables. In fact, it would seem that there are more languages, having syllables of different complexity, with weight-insensitive rhythm than with weight-sensitive rhythm. At the same time, we should perhaps expect that intrinsic properties of syllables are *likely* to create variability in the distribution of rhythmic beats.

In the following section I discuss three types of rhythmic pattern:

(21) a. Simple rhythm
b. Complex rhythm
i. Rhythm combining binary and ternary patterns
ii. Rhythm with clashes

This three-way distinction is a pre-theoretical one, which I make for convenience at the moment. A theoretically based classification will emerge from the subsequent discussion. A characteristic of simple rhythm is that it is *unidirectional*, whereas among the complex rhythms in most, perhaps all, of the cases *bidirectionality* is involved.

Simple rhythm is what Garde (1968) calls *echo rhythm*.[27] This refers to rhythmic beats that 'ripple away' from the accent:

(22) Initial stress and alternating rhythm: Pintupi (Hansen and Hansen 1969)

x						Accent
(σ	σ)	σ	σ	σ	σ	
x[28]		x		x		Echo rhythm (left-to-right)

Simple rhythm can be binary or ternary, a distinction that I will deal with in section 11.4.3.

Complex rhythm arises when the rhythmic melody anchors to the edge that is opposite to the primary accent. This is what, in van der Hulst (1984), I have called *polar* or *antipole rhythm*.[29] An example that is cited here is Piro:

[26] Pierrehumbert (1980) even maintains this for phonetic implementation, which makes it difficult to separate utterance-level rules from implementation rules. For a motivation of the difference I refer to van der Hulst (2011b, in prep. b).

[27] Actually he refers to 'echo accent'.

[28] If we assume that the phonetic interpretation is sensitive to the grid structure alone, rather than being able to peak into the (lexical) accent structure, the special status of the primary stress must be indicated in the grid structure by adding an extra gridmark. Recall that, for ease of presentation, I am not including such an extra mark in the diagrams.

[29] Gordon (2002) refers to these systems as *dual systems*, while Kager (2005a, 2005b) and others use the term *bidirectional systems*.

(23) Piro (Matteson 1965)

					x		Accent
σ	σ	σ	σ	σ	(σ	σ)	
x		x			x		Polar rhythm (left-to-right)

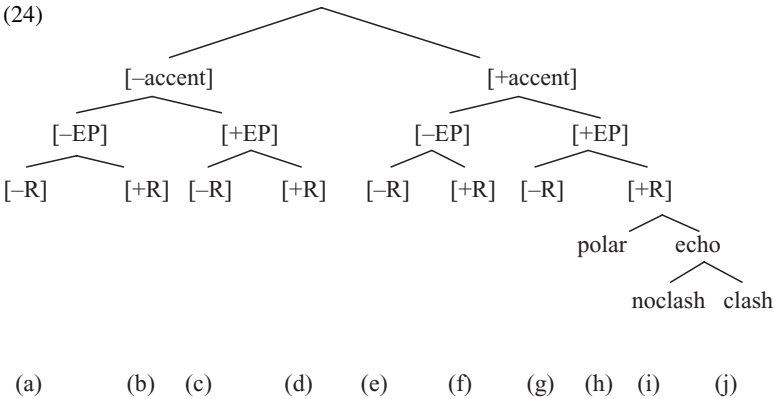
As shown, polar rhythm can create an *internal lapse*: it refrains from placing a beat on the third syllable because that would create a clash with the beat on the accented syllable. In general (perhaps always), rhythmic patterns avoid such clashes.

In section 11.4.4 I will make the proposal that polar rhythm results from two steps: the assignment of a beat (Edge Prominence) to the edge that lies opposite to the accent edge, which is followed by rhythm that echoes this beat, rather than the accent.

The third class of rhythmic systems is complex in that words are claimed to allow a clash between two rhythmically strong syllables, typically on the edge opposite to the primary stress. As we will see in section 11.4.5, it is possible that these systems, at least when the clash is found on the edge opposite to the edge of the primary stress, are also bidirectional in the sense of having a polar beat, but with rhythm this time echoing from the primary stress, running into a polar beat where a clash is created.

I conclude this section with a typology which displays the systems in terms of presence or absence of accence, polar Edge Prominence, and rhythm:

(24)



(a) non-accentual system without Edge Prominence or rhythm (section 11.3.3)
(b) non-accentual system with rhythm only (section 11.3.3)
(c) non-accentual system with Edge Prominence without rhythm (section 11.3.3)

(d) non-accentual system with Edge Prominence and rhythm (section 11.3.3)
(e) unidirectional accentual system without rhythm (section 11.4.1)
(f) unidirectional accentual system with echo rhythm (section 11.4.3)
(g) bidirectional accentual system without rhythm (section 11.4.4)
(h) bidirectional accentual systems with polar rhythm (section 11.4.4)
(i) bidirectional accentual systems with echo rhythm and no clash (section 11.4.4)
(j) bidirectional accentual systems with echo rhythm and clash (section 11.4.5)

In section 11.3.3 I mentioned the option of having no accent, which allows for a fully predictable utterance-level rhythm consisting of either Edge Prominence or rhythm or both, as well as having no rhythm at all (24a–d). In subsequent sections I will discuss the possibilities for rhythmic patterns in accentual systems (24e–j).

11.4.3 Rhythm in unidirectional systems

11.4.3.1 Weight-insensitive systems

In Gordon (2002) a survey is reported containing fifty-four weight-insensitive languages. Two of these display a clash (Gibwa and Biangai). I return to systems of this sort in section 11.4.5.[30] In (25) I list the possibilities showing the number of times each case is attested in Gordon's overview. I added one case, namely Hixkaryana, which is weight-sensitive, in a spot where I predict that we could also find a weight-insensitive case.[31]

Taking all these cases to be of the type in which rhythm echoes the accent location, we can say that in simple systems a rhythmic pattern ripples away from the primary stress, filling out the string of syllables exhaustively with a maximal number of beats (without creating a clash).[32] Given maximality, rhythmic beats on final syllables in Murinbara and on initial syllables in Weri are expected because they simply *fill out* the rhythmic alternation in an exhaustive manner. What needs explanation, then, is the fact that such a peripheral beat is apparently *an option* in Left-to-Right (LR) systems which we see by comparing Murinbara

[30] Kager mentions other 'clash systems', such as Gosiute Shoshone and Tauya. These two, together with Gibwa and Biangai, form precisely the four logical possibilities for clash systems, as I will show in section 11.4.5.

[31] There are special cases such as Djingili, in which, reportedly, there is only one echo of the primary stress.

[32] Some of the systems in Gordon's collection may have fully automatic stress, in which case the postulation of a lexical accent system might be questioned. However, as stated in section 11.2, I take independency of phrasal context as sufficient reason for postulating a lexical accent. Whether, in fact, in all reported cases such autonomy is guaranteed is uncertain, given that descriptions of 'word' stress are often based on one-word utterances; see de Lacy (this volume) and Gordon (this volume).

to Pintupi, the latter allowing a final lapse in odd-parity words. This means that the final beat in (25a) is a parametric option, which I will refer to as 'NonFinality (y/n)'. In Right-to-Left (RL) systems, however, initial lapses are excluded, which is why a minimal pair to Warao (in 25b) and a minimal pair to Weri in (25d), both with an initial lapse, are unattested.[33] This follows if rhythmification is exhaustive unless parametrically curtailed (by NonFinality).[34] The absence of these systems is explained by my approach because an initial syllable followed by a beatless syllable will always trigger rhythmic beat addition.[35]

(25) Weight-insensitive systems

Trochaic (53)

a. LR (32)		b. RL (12)	
x (Σσ)σσσσσσ x x x x	x (Σσ)σσσσσσ x x x x	x σσσσσσ(Σσ) x x x x	x σσσσσσ(Σσ) x x x
x (Σσ)σσσσσ x x x	x (Σσ)σσσσσ x x x x	x σσσσσ(Σσ) x x x	x σσσσσ(Σσ) x x x
Pintupi (14)	Murinbara (18)	Warao (12)	Unattested

Iambic (9)

c. LR (4)		d. RL (5)	
x (σΣ)σσσσσσσ x x x x	x (σΣ)σσσσσ x x x	x σσσσ(σΣ) x x x	x σσσσσσ(σΣ) x x x x
x (σΣ)σσσσσσ x x x x	x (σΣ)σσσσσσ x x x	x σσσσσ(σΣ) x x x	x σσσσσ(σΣ) x x x x
Araucanian (3)	[Hixkaryana]	unattested (0)	Weri (5)

[33] The unattested case in (25d) is what Hermans (2011) calls 'anti-Pintupi'. We could call the unattested case in (25b) 'anti-[Hixkaryana]', albeit that Hixkarayana is QS.

[34] The obligatoriness of an initial beat (i.e. the impossibility of an initial lapse) and the optionality of a final beat are reminiscent of the asymmetry between onsets and codas, in the sense that onsets are always possible, and indeed sometimes obligatory, whereas codas can be absent, sometimes obligatorily so:

Rhythm	*Syllable structure*
Initial beat (all languages)	Onset (all languages)
Final beat (some languages)	Coda (some languages)

The difference is that rhythmic patterns apply to all words, whereas the presence of onset (except in the case where onsets are obligatory) or coda is decided per individual syllable in each word.

[35] Hermans (2011) discusses two other unattested patterns, called 'anti-Garawa' and 'anti-Piro', both bidirectional. I will mention these (and why they are ill-formed) in section 11.3.4.

The question now to be asked is how rhythmic beat addition operates in detail.[36] It must not escape our attention that all systems attested in Gordon (2002), again ignoring the clash systems, are neutral with respect to the choice of iambic versus trochaic rhythm. We just add non-clashing beats, starting with the accented syllable, in a maximal fashion (as many as possible), with the possible exception of final beats. I will refer to this approach as Theory A ('free beat addition'). I will consider two alternatives and show that each is more complex than Theory A:

(26) Free beat addition (Theory A)

```
        x
σ   ⇒   σ
```

First, it could be argued that the impossibility of initial lapses and the possibility of final lapses reflect a 'trochaic bias':

(27) Trochaic beat addition (Theory B)

```
            x
σ   σ   ⇒   σ   σ
```

This approach, like Theory A, explains the absence of initial lapses without further ado, but it does require a 'Final Fill-out' parameter (instead of NonFinality) to account for the difference between Pintupi and Murinbara or between Araucanian and Hixkaryana. By postulating a trochaic bias for weight-insensitive systems, one would follow the spirit of Hayes (1995), who proposed to abandon the weight-insensitive iambic foot. Following that proposal and taking it further, it has been argued that there is perhaps no pressing need for 'iambic' rhythm at all. For example, in van de Vijver (1998) and van der Hulst (2000) we see that in foot theories, iambic feet have been losing ground to the point where some researchers denied their existence. Theory A and B are similar in complexity, with the difference that the free beat addition rule in (26) is, of course, a simpler rule than the trochaic rule in (27).

Second, let us consider a third theory. Prince (1983) makes a distinction between 'trough first' (iambic) or 'peak first' (trochaic) perfect gridding. If a distinction in two types of rhythm is made, we would *not*, in AF theory, have to stipulate the type of rhythm. Instead we could assume that the rhythmic pattern displays a *copy* of the pattern that is laid down in the accent window. This theory, however, needs not only a final fill-out parameter, but also an

[36] In a standard metrical analysis all systems would be derived in terms of binary feet operating from left to right (LR) or from right to left (RL). Some systems would require unary feet, which some researchers, like Kager (1991), have argued against. This would go toward explaining why clash systems are unexpected, but it also leads to the problem that cases like Murinbara and Weri, which would have unary feet not causing clashes, cannot be accounted for. This problem would disappear if one would follows de Haas (1991), who argued that causing or not causing clashes is the criterion for disallowing or allowing unary feet.

obligatory rule of 'Initial Fill-Out' to explain the absence of initial lapses. This is demonstrated in (28). As before, primary stress is represented by capital sigma and rhythmic beats are underlined:

(28)

Even-parity	Odd-parity	
a. Initial accent: trochaic rhythm		
(Σσ) σσ σσ σσ x x x x	(Σσ) σσ σσ σ x x x [x]	Final fill-out (y/n)
b. Penultimate accent: trochaic rhythm		
σσ σσ σσ (Σσ) x x x x	σσ σσ σ (Σσ) x x x	
c. Peninitial accent: iambic rhythm		
(σΣ) σσ σσ σσ x x x [x]	(σΣ) σσ σσ σ x x x	Final fill-out (y/n)
d. Final accent: iambic rhythm		
σσ σσ σσ (σΣ) x x x x	σ σσ σσ (σΣ) [x] x x x	Initial fill-out

This leads to a slightly more complicated theory (called 'Theory C').

In sum, we have three approaches to weight-insensitive systems which are descriptively equivalent, while differing in complexity:

(29)

Theory A	Theory B	Theory C
Free beat addition	Trochaic beat addition	Pattern copy
+ NonFinality (y/n)	+ Final fill-out (y/n)	+ Initial fill-out
		+ Final fill-out (y/n)

Given that Theory C is more complex than the other two theories, and given that 'free beat addition' (Theory A) is simpler than trochaic beat addition (Theory B), it would seem that we have to go with Theory A.

Let us briefly look at ternary systems, adopting Theory A. We can then say that a ternary system arises by *maximizing the occurrence of lapses* (defining a lapse as a sequence of two unstressed syllables), while binary systems maximize the occurrence of beats. That a rhythmic sequence of two syllables can remain without a beat, but not three, is understandable since a three-syllable sequence flanked by rhythmic beats can undergo free beat addition without creating a clash, while a two-syllable sequence cannot:

(30)

a. Binary pattern

```
x       x       x       x
σ   σ   σ   σ   σ   σ   σ
```

b. Ternary pattern

```
    x       x       x
    σ   σ   σ   σ   σ   σ   σ
```

c. *Quaternary pattern

```
    x       x       x
    σ   σ   σ   σ   σ   σ   σ   σ   σ
```

Since, in (30a) and (30b) free beat addition cannot add any beat without creating a clash, binary and ternary systems represent the only two possible rhythms. The quaternary pattern (30c) can undergo beat addition without creating clashes, which then gives rise to a binary pattern.

We find ternary rhythm in Cayuvava (with antepenultimate accent and ternary echo rhythm; Foster 1982):

(31)
```
x           x           x           R (echo)
[σ  σ  σ  σ  σ  σ  Σ  σ  σ]
```

It is important to note that if we are one syllable short of creating an initial dactylic sequence, an initial lapse results in Cayuvava:

(32)
```
            x           x           R (echo)
[σ  σ  σ  σ  σ  Σ  σ  σ]
```

If we were to adopt Theory B, we could capture the ternary pattern (including the initial lapse) by formulating a trochaic (or rather dactylic) beat addition rule:

(33) <u>Beat addition</u>
```
                    x
σ  σ  σ  ⇒  σ  σ  σ
```

Here, given the scarcity of data involving ternary patterns, it is difficult to differentiate between the three theories in (29). I know of no minimal pair to Cayuvava that has an initial beat in a case like (32). But, if ternary systems allow a choice of this kind (which would not surprise me), all three theories would have to adopt an Initial Fill-Out parameter (which could be construed as the Edge Prominence rule), although in Theory B we could build this into the rhythmic beat addition rule as follows:

(34) <u>Beat addition</u>
```
                    x
σ  σ  (σ)  ⇒  σ  σ  (σ)
```

Another language with a ternary pattern, Tripura Bangla (Houghton 2008), has initial accent with echo rhythm operating in a LR mode:

(35)
```
x           x           x           R (echo)
[Σ  σ  σ  σ  σ  σ  σ  σ]
```

Note that a beat must be added to the penultimate syllable in an even-parity sequence, which suggests that the beat addition rule in (34) is required. In this case, it would seem less likely to find a minimal pair *without* the shorter clause because that would leave the string in (35) ending in a four-syllable lapse. In

Theory A, this situation is prohibited given the definition of lapse. Hence a rhythmic beat must be added.[37]

Thus, Theory A generates the patterns of Cayuvava (in (31–32)) and Tripura Bangla (in (35)) directly as the only two possibilities. However, ternary systems are not very frequent and perhaps little can be said about them beyond what is said here. Cayuvava, Tripura Bangla, and some other examples are discussed in more detail in van der Hulst (in prep a.).[38] In the remainder of this chapter, I will focus on binary rhythm.

In conclusion, Theory A (free beat addition – subject to no clash) explains in the simplest way why the binary patterns that Gordon has found to exist (ignoring the clash systems for the moment) and other conceivable patterns do not (granted that Hixkaryana fills in for a weight-insensitive (WI) system that has a final lapse). Within this theory, ternary systems arise when *binary lapses* are maximized (which is parameter (1d)).

11.4.3.2 Weight-sensitive systems

We now turn to weight-sensitive (WS) systems. If the rhythmic domain differentiates between light and heavy syllables, the distribution of rhythmic beats must pay respect to this distinction: heavy syllables will be associated, like accented syllables, to a beat, leaving intermediate strings of light syllables open for free beat addition. This then requires a weight-parameter:

(36) Weight (yes/no) (= 1c)

The crucial issue in accounting for rhythm in WS systems is how precisely beat addition interacts with heavy syllables. Again, I will compare the three different theories in (29); (37) spells out which rhythmic patterns have been attested:[39]

[37] One might argue that free beat addition could also place a beat on the antepenultimate syllable, but that would be precluded given the directional nature of free beat addition, since in a ternary system each application of beat addition seeks to skip a lapse.

[38] The case of Sentani is also very interesting, posing some special challenges; see Elenbaas (1999) and Elenbaas and Kager (1999).

[39] Here we are still considering systems in which rhythm echoes the accent position. In echo systems of this kind, rhythm can ripple away from the primary stress, creating a LR rhythm if stress is on the left edge and creating a RL rhythm if it is on the right edge. However, the interactions between rhythm and heavy syllables found in echo systems are expected to be the same as those found in polar systems, which are discussed in section 11.4.4. In other words, the interaction between rhythm and heavy syllables, while dependent on the direction of the rhythm, is not dependent on whether the rhythm echoes the accent or moves toward it from the opposite edge.

(37) The interaction of rhythm and weight[40]

LR	RL
l l h	l l h
x x l l h (a: Menomini)	x x l l h (e: unattested)
x x l l h (b: Cahuilla)	x x l l h (f: Fijian)
h l l	h l l
x x h l l (c: Menomini)	x x h l l (g: unattested)
x x h l l (d: Cahuilla)	x x h l l (h: Fijian)

In LR mode, we find two different cases. In Menomini (37a) beat addition can clash into a heavy syllable, namely when there are two light syllables preceding a heavy syllable; this is called a 'Forward Clash' (Prince 1983). Following a heavy syllable, one light syllable is skipped (37c). The reverse is found in Cahuilla (37b, d). Taken at face value, this difference suggests the copy theory of rhythm (Theory C) if we adopt the following copying table:

(38)

Initial heavy or second (I/S)	iambic rhythm	Menomini
Ultimate heavy or ultimate (U/U)	iambic rhythm	unattested
Initial heavy or initial (I/I)	trochaic rhythm	Cahuilla
Ultimate heavy or penult (U/P)	trochaic rhythm	Fijian

The problem is that we do not find the same possibilities in the RL systems. To demonstrate, I replace (37) by the more explicit (39), this time putting in foot boundaries, assuming the asymmetric foot theory of Hayes (1995) (see (39)).

In RL mode no clear evidence for iambic rhythm can be found. Hayes (1995: 262) notes this and he regards it as an accidental gap (pp. 265–6). Kager (1993) explains the total absence of RL iambic weight-sensitive feet[41] with reference to *Backward Clash Avoidance*. An apparent backward clash *can* arise in LR mode, as in the Cahuilla case in (39d). In this case the clash is apparent because by adding a beat to a post-heavy light syllable no clash is actually created, if

[40] Hayes (1995) analyzes the languages in this table: Menomini (pp. 218–21), Cahuilla (pp. 132–40), and Fijian (pp. 142–9), each of which have the patterns in (37), which is not to say that these patterns embody full descriptions of the stress system of these languages.

[41] In Kager's theory, the weight-sensitive iambic foot is a moraic foot, replacing Hayes's unbalanced foot type (which allows a light–heavy sequence), but that does not affect the present discussion.

(39) The interaction of rhythm and weight

	Left-edge accent + LR echo		Right-edge accent + RL echo
	l l h		l l h
I/S accent + Iambic echo	x x (l l) (h) (a: Menomini) [forward clash]	U/U accent + iambic echo	x x (l l) (h) (e: unattested) [backward clash]
I/I initial accent +Trochaic echo	x x (l l) (h) (b: Cahuilla)	U/P accent + trochaic echo	x x (l l) (h) (f: Fijian)
	h l l		h l l
I/S accent + Iambic echo	x x h) (l l) (c: Menomini)	U/U accent + iambic echo	x x h) (l l) (g: unattested)
I/I initial accent + Trochaic echo	x x (h) (l l) (d: Cahuilla) [apparent backward clash]	U/P accent + trochaic echo	x x (h) (l l) (h: Fijian) [apparent forward clash]

it is assumed, as Kager points out, that heavy syllables have an inherent '(x.)' pattern, branching rhymes being left-headed:

(40) $\sigma \quad \sigma \quad \underset{x}{[\mu\mu]_{\sigma}} \quad \underset{x}{\underline{\sigma}} \quad \sigma \quad \sigma$

In conclusion, while a RL mode does not need a trochaic/iambic distinction, for the LR mode the distinction between trochaic and iambic rhythm remains necessary (which appears to necessitate the copy theory, Theory C). Note that we must assume that a forward clash (as in Menomini, (39a)) is tolerated and here it could be argued that a clash in this case cannot be prevented if beat addition cannot 'look ahead' (Prince 1983).

We now face a problem. In weight-*in*sensitive systems, Theory C (the copy theory) is possible, but undesirable, given that free beat addition (Theory A) or trochaic beat addition (Theory B) also work and are simpler, with Theory A being the simplest theory. But in weight-sensitive systems we seem to need Theory C.

What would it take for Theory A (or B) to deal with weight-sensitive systems? We first should note that the RL cases are, in fact, fully compatible with Theory A or B since precisely in this direction of application we need to

block the use of iambic feet if Theory C is adopted. This means that Theory C is only crucially required for LR weight-sensitive systems to make the difference between alleged trochaic and iambic patterns. This warrants a closer examination of the weight-sensitive LR cases. Cahuilla, the 'trochaic case', is compatible with Theory A given that a beat following a heavy syllable does not count as a clash (see (40)). Thus, the only type of case that stands in the way of Theory A is the case which Hayes (1995) analyzes as a LR weight-sensitive iambic system, such as Menomini, which allows the patterns in (41). For comparison, I have added the corresponding patterns in Cahuilla in (42):

(41) Menomini

a. (σ σ) ([μμ]$_{\sigma}$) σ σ σ (=39a)
x x

b. σ (σ [μμ]$_{\sigma}$) (σ σ) σ (=39c)
x x

(42) Cahuilla

a. (σ σ) ([μμ]$_{\sigma}$) σ σ σ (=39b)
x x

b. σ (σ [μμ]$_{\sigma}$) (σ σ) σ (=39d)
x x

It is interesting that Hayes claims that Menomini has a rule of *iambic lengthening*, which effectively makes syllables bimoraic in all cases where they precede a bimoraic syllable (see Hayes 1995: 338).

(43) σ [μμ]$_{\sigma}$ [μμ]$_{\sigma}$ σ σ σ (=41a after lengthening)
x x

This means that clashes are not desirable, even in such alleged iambic systems, which all seem to have either iambic lengthening or some sort of destressing of the pre-heavy light syllable. We could thus assume that the prohibition on clashes is always maintained if it is the case that a forward clash is always immediately 'repaired' (indicated in (44a) as 'l (>h)' for iambic lengthening). The problem is that this does not take away the difference between Menomini and Cahuilla, since in a sequence 'h l l h' both languages would display a different rhythm:

(44) a. Menomini b. Cahuilla

a. Menomini				b. Cahuilla			
x		x	x	x	x		x
h	l	l (>h)	h	h	l	l	h

Rather than giving in to Theory C, let us give Theory A (and Theory B) another chance and ask whether the differences in rhythmic patterns between (41) and

(42) can also be attributed to another factor than the alleged distinction between trochaic and iambic rhythm. Note that in Hayes's foot inventory there are *two* differences between the two types of weight-sensitive feet. Iambic feet are said to be *syllabic* in that combinations of light and heavy syllables form a (maximal) iambic foot, while trochaic feet are said to be moraic in that they maximally (and minimally) contain two moras:

(45) iambic + syllabic trochaic + moraic

Suppose, then, that we attribute the difference between (41) and (42) (or between (39a) and (39b)) to a difference in *the type of unit* that is rhythmified. Assuming Theory A or B we can derive the difference between the two types of weight-sensitive systems as the result of rhythm being syllabic or moraic. With this approach we also need a stipulation, namely that in syllabic systems beat addition can create a forward clash (which will be subject to repair in the form of iambic lengthening or destressing):

(46) The interaction of rhythm and weight (revised)

	LR	RL
	l l h	l l h
Syllabic	x x [forward clash allowed] l l h (a: Menomini)	x x l l h (e: unattested)
Moraic	x x l l h (b: Cahuilla)	x x l l h (f: Fijian)
	h l l	h l l
Syllabic	x x h l l (c: Menomini)	x x h l l (g: unattested)
Moraic	x x h l l (d: Cahuilla)	x x h l l (h: Fijian)

Again starting with the left side of (46), the difference between (a) and (b) follows from the stipulation that a syllabic system allows a forward clash. The difference between (c) and (d) also follows because, all other clashes being forbidden, a syllabic system has to skip a syllable after a heavy syllable, but a moraic system does not, given that the second mora of the heavy syllable 'prevents' a clash.

On the right side of (46), we have cases of moraic trochaic rhythm (like Fijian). I do not have an example of syllabic trochaic rhythm. Such a case, however would *not* produce the patterns in (46e, g), rather (given that forward clashes are allowed in a syllabic system and backward clashes never are), it would converge on the same pattern that is found in RL moraic systems. This means that, given Theory A or B, there is no 'unattested case' in the RL mode.

Rather, in RL mode syllabic and moraic rhythm converge on the same pattern, which means that Fijian can be moraic or syllabic:

(47) Theory A or B

	LR	RL
Syllabic	Menomini	Fijian
Moraic	Cahuilla	Fijian

The question might be raised as to *why* rhythm is clash-insensitive in forward mode when weight is computed at the syllable level, whereas when rhythm is computed at the moraic level no such tolerance exists. It is perhaps reasonable to think that what makes syllabic systems unable to 'see' an upcoming clash in forward-looking mode is that, in a syllabic system, syllabic boundaries create an *opacity effect*, prohibiting beat addition from seeing that the upcoming syllable is internally bimoraic and thus heavy.

In sum, Theory A (or B), augmented with the syllable/mora parameter, is actually superior to Theory C because the latter theory leaves an unexplained gap:

(48) Theory C

	LR	RL
Iambic	Menomini	gap
Trochaic	Cahuilla	Fijian

Since Theory A is simpler than Theory B, I conclude that the claim that all rhythm is free is tenable,[42] ending up with the rhythm parameters in (49):

(49) Rhythm parameters (Theory A)
a. Weight (y/n)
b. Lapse (y/n)
c. NonFinality (y/n)

We now turn to rhythm in bidirectional systems.

[42] An objection against a total dismissal of the iambic/trochaic distinction could be based on an analysis of Creek, which has been described as a count system that has LR *iambic* footing, with primary stress on the rightmost foot. An easy way out for cases of this type would be to say that the first syllable is 'extrametrical', but allowing that approach makes it in general very difficult to distinguish between a theory that prohibits iambic rhythm and one that does not. In van der Hulst (in prep. a), I discuss count systems in more detail and suggest that they may be due to a *hidden accent rule* that places an accent on the second syllable. This also solves the problem that otherwise not only the iambic/trochaic distinction is needed, but also, with neither accent nor polar beat to refer to, a direction parameter would be needed.

11.4.4 Rhythm in bidirectional systems

In section 11.2, I mentioned that rhythmic languages may have either echo or 'polar' rhythm. The difference was illustrated with two languages with different accent locations, rhythm being either echo (Pintupi, initial accent) or polar (Piro, penultimate accent). To illustrate the difference with another minimal pair, consider Pintupi and Garawa, where this time the accent location is the same:

(50) a. Pintupi (echo)

```
x                                   Accent
(σ   σ)   σ   σ   σ   σ   σ
x         x       x       x         Rhythm (LR, echo)
```

b. Garawa (polar)

```
x                                   Accent
(σ   σ)   σ   σ   σ   σ   σ
x             x       x             Rhythm (RL, polar)
```

It would seem that the conclusion that rhythm in Garawa comes from the right is inevitable, since there is otherwise no good explanation for the consistent beat on the penultimate syllable, irrespective of the number of syllables.[43]

Levin (1988), Kager (1991, 2001, 2005a, 2005b), Gordon (2002), Alber (2005), Hyde (2008), and Houghton (2008) all discuss bidirectional systems within the context of OT.[44] The main objective of these authors is to explain why only certain types of polar systems exist. However, instead of first allowing 'everything' and then excluding what is not attested (the OT approach), we can

[43] Nonetheless, Halle and Vergnaud (1987) propose a unidirectional analysis. In fact, their analysis sees Garawa as a 'count system'. To get the primary stress consistently on the first syllable, they then need a rule that deletes a branching foot in post-clash position (in words with an odd number of syllables):

```
x
x     x     x     x
(σ)   (σ    σ)    (σ    σ)    (σ    σ)    ⇒
x
x             x           x
(σ    σ     σ)    (σ    σ)    (σ    σ)
```

As pointed out in Kager (1991), the problem with allowing destressing rules of this type is that they can be used to generate a variety of unattested patterns, specifically patterns that have a lapse that is not adjacent to the primary stress. Whether such lapses are in fact intolerable is questionable. I return to this issue below. In any event, it is clear that the most straightforward way to avoid predicting impossible patterns caused by using destressing rules is to avoid, i.e. ban, destressing rules altogether, at least when they are motivated by the need to patch up results that are produced by the stress algorithm. If corrective destressing rules of whatever sort are banned, there is only one possible analysis for Garawa and English, which is the bidirectional one.

[44] Also see Shaw (1985) for a different kind of situation, in which there are two competing accent rules.

also characterize the polar systems that are attested directly. It then follows that everything else is not possible; this is the approach that I follow.

In (51), following Kager (2005a, 2005b) we find a (preliminary) typology of bidirectional systems:

(51) Bidirectional systems

a. Weight-insensitive trochaic systems[45]

RL	LR	RL	LR
$(\Sigma\sigma)\sigma(\underline{\sigma}\sigma)(\underline{\sigma}\sigma)$	$(\underline{\sigma}\sigma)(\underline{\sigma}\sigma)\sigma(\Sigma\sigma)$	$(\underline{\sigma}\sigma)\sigma(\underline{\sigma}\sigma)(\Sigma\sigma)$	$(\Sigma\sigma)(\underline{\sigma}\sigma)\sigma(\underline{\sigma}\sigma)$
Garawa	Piro	unattested (>Spanish)	unattested

b. Weight-insensitive iambic systems

RL	LR	RL	LR
$(\sigma\Sigma)\sigma(\sigma\underline{\sigma})(\sigma\underline{\sigma})$	$(\sigma\underline{\sigma})(\sigma\underline{\sigma})\sigma(\sigma\Sigma)$	$(\sigma\underline{\sigma})\sigma(\sigma\underline{\sigma})(\sigma\Sigma)$	$(\sigma\Sigma)(\sigma\underline{\sigma})\sigma(\sigma\underline{\sigma})$
unattested	unattested[46]	unattested	unattested[47]

Many patterns are claimed to be unattested (see Kager 2005a, 2005b; Hermans 2011; Hyde, this volume). Kager proposes to rule out all systems in the third and fourth column in (51a, b). In each of these cases we have a medial lapse that is *not* adjacent to the primary stress, and Kager proposes a constraint that prohibits precisely this. The first two cases in the iambic row (51b) are ruled out in terms of other constraints. However, it seems much simpler to weed out the entire iambic row by appealing to Theory B, in which only trochaic rhythm is permitted. This leaves us with the cases in (51a), two of which are then claimed to be impossible. At this point it is not clear how Theory A would derive the same result if we assume (as for Theory B) that rhythm can start at the edge opposite to the edge of the accent.

However, whether the two unattested cases in (51a) are truly impossible systems is debatable. As pointed out in Hyde (this volume), Spanish is reported to have this pattern as one of two possibilities, the other possibility being a unidirectional pattern; see Harris (1983) and Hualde and Nadeu (this volume):

(52) Colloquial pattern: $\grave{\sigma}\,\sigma\sigma\grave{\sigma}\,\sigma\acute{\sigma}\,\sigma$ (bidirectional, with an initial dactyl)
Rhetorical pattern: $\sigma\grave{\sigma}\,\sigma\grave{\sigma}\,\sigma\acute{\sigma}\,\sigma$ (unidirectional)

Given the possibility of the colloquial pattern, the question arises as to how this pattern can be derived. One possibility offered in Roca (1986) is to postulate an echo rhythm rippling away from the accent *plus* a rule that shifts a beat to the initial syllable when an odd number of syllables precede the stress-accented syllable. Here, as indicated in section 11.1, I will propose that this pattern (as well as all bidirectional systems) arises from a two-step process. First, a polar beat is assigned to the edge that lies opposite to the edge of the accent and then free rhythmic beat addition fills in the space in between the polar beat and the

[45] Kager (2005a) operates with a theory that excludes the use of unary feet.
[46] This is the system that Hermans (2011) calls 'anti-Garawa'.
[47] This is the system that Hermans (2011) calls 'anti-Piro'.

accent, either departing from the polar beat (as in Piro and Garawa) or from the accent (as in colloquial Spanish). This proposal not only allows us to adopt Theory A (leaving only the rightmost pattern in (5la) as unattested), there is additional motivation for it, as I will now show.

If bidirectionality requires a polar beat, we would expect that such polar beats can occur independently from rhythm. In (53) I present a list of bidirectional systems that have been mentioned in Kager (1991, 2001, 2005a, 2005b), Gordon (2002), Alber (2005), Hyde (2008), and Houghton (2008). This list first confirms the absence of systems as in (51b). More crucially, we note that in many cases (a majority in fact), here marked with an asterisk, there is no rhythm intermediate between the primary stress and the polar beat:

(53) Attested bidirectional systems

a. Systems with left-edge primary stress

Accent \ Polar rhythm)	U	PU	APU
I	(Tauya)	Garawa Nakara Watjarri*, Walmatjarri[48] Lower Sorbian* Gugu Yalanji	Walmatjarri* Mingrelian*
S	–	–	–
T	–	–	–

b. Systems with right-edge primary stress

Accent \ Polar rhythm	I	S	T
U	Gosiute Shoshone Canadian Fr* Udihe* Armenian*	–	–
PU	Piro Polish Sibutu Sama* Anyulu* Awtuw* Chimalapa* Sanuma* Murut*	?Southern Paiute	–
APU	Georgian*	–	–

[48] Walmatjarri* reportedly has two patterns: the non-primary beat can also be on the APU syllable.

What we see is that, for initial accent systems, the polar beat can be on the penultimate syllable or on the antepenultimate syllable, whereas for final accent systems it can only be initial. Thus the typical pattern is the one found in Garawa, repeated here for convenience, where the polar beat (indicated in bold) is the source of echo rhythm:

(54) Garawa

x							Accent
(σ	σ)	σ	σ	σ	σ	σ	
x			x		**x**		Polar beat + echo

Since third and second syllable accent systems are rare we are not surprised to have no polar examples. These could be accidental gaps.

For systems with right-edge accent, the case of Piro is a representative example with penultimate accent and rhythm rippling away from a polar beat:

(55) Piro

					x		Accent
σ	σ	σ	σ	σ	(σ	σ)	
x		x			x		Polar beat + echo

This pattern perhaps also applies to English and Dutch.[49] An example that has a polar beat and no rhythm is found in Sibutu Sama (Elenbaas and Kager 1999; Gordon 2002):

(56) Sibutu Sama

a.	bɪs.(sá.la)	'talk'
b.	bìs.sa.(lá.han)	'persuading'
c.	bìs.sa.la.(hán.na)	'he is persuading'
d.	bìs.sa.la.han.(ká.mi)	'we are persuading'

Note that in (56a) there is no polar beat when this would clash with the primary stressed syllable.[50]

[49] For Dutch see Booij (1995) and for English de Haas (1991).

[50] Hualde and Nadeu (this volume) show that in Spanish polar beats are not avoided when immediately preceding the primary stress. This would imply that such clashes are not universally ruled out. The same is true in English as long as the initial syllable is heavy. It could be argued, however, that in English, whether heavy pretonic syllables have secondary stress is lexically determined, given minimal pairs such as *prodúce* vs. *pròtráct*. I would instead argue that pretonic reduction is a sound change in progress which is subject to lexical diffusion. Words that have been hit by this process fail to undergo the beat addition Edge Prominence rule. This allows me to maintain that secondary stresses cannot be lexically specified. It has been argued that loan words that have submitted themselves to the stress regime of the receiving language keep the stress location of the donor language as an unpredictable secondary stress, as for example in Hawaiian, but Paul de Lacy (p.c.) informs me that these claims are incorrect. See van der Hulst (in prep. a) for discussion.

Polar beats create what van Zonneveld (1982) has called a 'hammock pattern' and what Fónagy (1980) calls an 'accentual arch'. This idea is worked out more explicitly in di Cristo (1998), who proposes two principles for prominence assignment: the Accentual Bipolarization Principle (ABP) and the Accentual Hierarchization Principle (AHP). The ABP captures the tendency that at each level of prosodic structure the first and last items stand out in prominence. The AHP states that the rightmost prominent item will be the most prominent unit. Assuming that it does not have to be the rightmost item that always wins out, this approach is compatible with the proposal to see the polar beat as an independent phenomenon. This idea is also proposed in Moskal (submitted), who refers to this mechanism as *Edge Prominence*, a term that has been adopted here (alongside Initial Beat Addition). In line with these ideas, let us conclude that the polar beat is firmly separated from the rhythmic alternation that may or may not be present in the 'valley' between the polar beat and the accent.

There are three additional arguments in favor of the two-step approach to polar systems. First, when there is rhythm, the first polar beat is generally described as being stronger than the intervening rhythmic beats. This suggests that the initial non-primary stress has a different source than the other non-primary stresses. This argument leads to a second argument, namely that in utterance structure we see that secondary stress resulting from both polar beats and primary stress can function as anchors for intonational pitch accents. In English, for example, polar beats can attract intonational tones, which gives rise to the well-known pairs in (57), where capitalized syllables carry a pitch accent:

(57) a. (That chair is made of) bamBOO
b. BAMboo enCLOSures

Here, in the present analysis, (bam) has a polar beat while (boo) carries the accent. Intervening alternating stresses cannot attract intonational pitch accents, which again suggests that there are two kinds of non-primary stress. In the next section, we will see a further possible argument based on the fact that the mechanism of 'Edge Prominence' offers an explanation for why there can be clash systems (Moskal submitted).

I also here refer to the fact that, in a number of places, Hayes (1995) makes reference to 'phonetic strengthening' or 'phonetic final lengthening' to explain a perceived or reported prominence of peripheral syllables that cannot be straightforwardly explained by the metrical algorithm that he proposes for the language in question. I suspect that cases of this type could also be cited to further motivate the mechanism of Edge Prominence.

In conclusion, I suggest that we enrich the model with a post-grammatical module that is responsible for creating a hammock pattern. It is not obvious that this post-grammatical module has access to the same repertoire of parameters that the lexical accent module must contain. There is, for example, no evidence for anything beyond an initial 'trochaic' '(x.)' domain which is also the most common final pattern (allowing for Extrametricality in cases such as Walmatjarri and Mingrelian). Here I refrain from proposing a formalization of the polar module, but let me add that it would not seem correct to grant the polar rule lexical status since its application may be dependent on phrasal context, as can be illustrated by a pair of examples from Prince (1983):

(58) a. Fórt Ticònderóga
b. Tìconderóga

In (58a), the weight of the second syllable in combination with an immediately preceding primary stress disfavors the initial polar beat. (This shows that Edge Prominence *can* be weight-sensitive.)

It is also interesting to note that the polar beats can be *re*analyzed as the lexical accent, leading to 'accent shifts' from, for example, penultimate accent to initial accent or vice versa, as exemplified in the aboriginal languages of Australia (see Goedemans 2010) and the Slavic languages (with penultimate accent in Polish and initial accent in Czech; see Dogil 1999). Perhaps cases of 'competing stress rules' as reported in Shaw (1985) can be interpreted in this light, seeing one of the competing stress rules as the innovating pattern, arising from Edge Prominence.

11.4.5 Systems with rhythmic clashes?

In this final subsection I turn to systems that display clashes. The general idea is this. It would seem that rhythmic beat addition cannot cause clashes between alternating rhythmic beats (which includes the rhythmic beat associated with the accent). I suggest that clashes are allowed only if they originate from different sources. As we have seen in the preceding section, rhythmic beats can clash with beats that mark heavy syllables. We will now see that rhythmic beats can also clash with beats that result from the Edge Prominence rule.

In (59), following Kager (2001), Gordon (2002), and Hyde (this volume), we have several systems that systematically allow clashes. In fact, there is a case for each direction and rhythmic type:

(59) Clash systems

	LR	RL
Trochee	a. Gosiute Shoshone (Σσ)σσσσ	b. Biangai[51] σσσσσ(Σσ)
Iamb	c. Gibwa (σΣ)σσσσσ	d. Tauya σσσσ(σΣ)

None of these cases are discussed in Hayes (1995), but he does report that Southern Paiute which has second syllable accent and rightward rhythm does not have a final beat in words with an even number of syllables but instead has a beat on the penultimate syllable, which creates a clash between the antepenultimate and penultimate syllables. According to Hyde (this volume) we also find that pattern in Aguaruna and he notes that the reverse of this pattern is not attested:

(60)

	LR	RL
Trochee	Southern Paiute (σΣ)σσσσσσ	Not attested σσσσσσ(Σσ)

Let us take a closer look at each of these systems, first case (59a):

(61) Gosiute Shosone (Miller 1996)
Initial accent plus echo and fixed final beat

```
 x
(σ    σ)   σ    σ    σ
 x         x         x
 x
(σ    σ)   σ    σ    σ    σ
 x         x         x    x
```

The final beat cannot be accounted for in terms of foot assignment in even-numbered words, so my suggestion is (following Moskal submitted) that it can be understood as a polar beat. In this analysis the clash results because the rhythm that echoes the primary stress clashes into the polar beat (indicated by a bold ‘x’). The Southern Paiute case also falls in this type, having a polar beat on the penultimate syllable.

The next case is (59b):

(62) Biangai (Dubert and Dubert 1973)
Penultimate accent plus echo and fixed initial beat

```
                         x
σ    σ    σ    σ    σ    (σ    σ)
x    x         x         x
```

[51] A reviewer notes that Passamaquoddy, Maithili, and South Conchucos Quechua also have the ‘Biangai’ pattern.

As mentioned, we could derive this (in words of any number of syllables) in terms of a RL trochee, *allowing unary feet in clash*. The alternative, within the present approach, is to analyze the initial beat as polar with rhythm that echoes the primary stress clashing into it.

Third, we turn to case (59c):

(63) Ojibwa (Kaye 1973; Piggott 1983)
Second syllable accent:

```
      x
(σ    σ)   σ    σ    σ    σ    σ
      x         X         x    x
```

Kaye (1973) and Piggott (1983) propose an analysis for Ojibwa using rightward iambs, allowing degenerate feet (data cited from Kager 2007):

(64)
a. na.gá.mò 'he sings'
b. ni.bí.mo.sè 'I walk'
c. ni.ná.ga.mò.miń 'we sing'

However, in this case too we could appeal to a polar final beat and rhythm echoing the primary stress clashing into this final beat.

Fourth, we discuss case (59d):

(65) Tauya (McDonald 1990)

```
                    x
σ    σ    σ    (σ   σ)
x         X         x
                         x
σ    σ    σ    σ    (σ   σ)
x    x         x         x
```

As in the case of Gosiute Shoshone, no metrical analysis is available for words with an even number of syllables, but we could once more appeal to a polar beat analysis.

In conclusion, Gibwa and Biangai *could* be dealt with in a metrical approach by allowing unary feet in clash (which would have to be considered very exceptional), but the other two systems cannot even be metrically represented. Interestingly, Hyde (this volume) argues that Gosiute Shoshone and Tauya have been misanalyzed and thus do not constitute examples of the relevant clash patterns. If, however, all the reported clash systems represent a genuine phenomenon, this strengthens the idea that in addition to accent and rhythm there is a third player that can contribute to the prominence profile of words, but given the available data and controversies we need further research regarding the relevance of clash systems before we base firm conclusions on them.

11.5 Conclusions

In this chapter I have shown that the available evidence regarding word-internal rhythm can be accounted for in terms of the following set of parameters:

(66) Rhythm parameters (Theory A)
  a. Polar beat (y/n)
  b. Rhythm (polar/echo)
  c. Weight (y/n)
  d. Lapse (y/n)
  e. NonFinality (y/n)

The polar beat parameter regulates the presence of Edge Prominence, i.e. prominence on the edge that lies opposite to the primary stress, thus creating a hammock pattern. Various arguments have been presented that strongly suggest the need for recognizing Edge Prominence as an independent parameter. Parameter (b) indicates whether rhythm is echoing the accent or, if present, the polar beat. Parameter (c) decides whether rhythm is weight-sensitive and parameter (d) decides whether rhythm is binary or ternary. Parameter (e) decides whether the final syllable is provided with a rhythmic beat or not.

I have shown that these parameters account for the attested variety of languages in terms of their rhythmic properties (see (24), (25), (46), (51), (53), (59)). Together with the accentual theory proposed in van der Hulst (2012), here summarized in section 11.3, the present chapter offers a comprehensive account of what is presently known about the class of possible word stress systems.

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