Representing rhythm

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1 Introduction[1]

In many so-called stress languages, the rhythmic profile of words results from two *separate* procedures: accent and rhythm. 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 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 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). 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.

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 4.4.

4 See Vaysman (2009) for a similar view.

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, which are due to a variety of factors such as (see the introduction to this volume, 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

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 a short hand, 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).

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 on 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'.

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 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]

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, 2009, 2011a, 2012, in prep a.; van der Hulst and Goedemans, this volume.

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 others 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 3.3 for some discussion of the latter situation.

↓
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
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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
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This extra grid mark 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 grid mark 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

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 his respect, AF-theory is making the claim that rhythm comes second twice: both the lexical accent and the polar rule take precedence over rhythm.

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 grid mark 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:

(5) STEP 1

F		F		F		Group from R-to-L into bounded left-headed foot
a	pa	la	chi	co	la	

STEP 2

						Group feet into an unbounded right-headed word tree
F		F		F		
a	pa	la	chi	co	la	

STEP 3

F		F		F		
a	pa	la	chi	co	la	
x		x		x		Grid construction
				x		

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		

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.

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 OT-manner:

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 Vayman (2009) also presents a model in which foot constituency is assigned on the basis of a grid structure.

(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 Optimality Theory (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 *evaluates* structures rather than building them. If we adopt the motto 'let there be structures' (the OT generator) and we have blocks of constraints that bear on the 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 this 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 4 by an extensive discussion of rhythm. In section 5, I present my main results and conclusions.

3 The accentual module

This section summarizes the proposal in van der Hulst (2012).

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, ultimate, penultimate, antepenultimate):[17]

(10) Possible accent locations in bounded systems

Left			*Right*		

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.

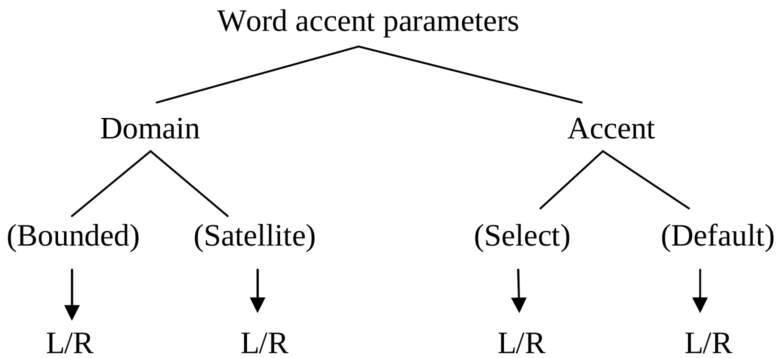
16 A more extensive discussion can be found in van der Hulst (2009, 2012, in prep.a).

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 a). 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: http://www.unileiden.net/stresstyp/.

Initial	*Second*	*Third*	*Antepenultimate*	*Penultimate*	*Ultimate*
Czech Finnish	Dakota	Winnebago	Macedonian	Polish	Turkish French

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 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 on 'left':

(15) Antepenultimate accent

{ (x .) . }

σ 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 (see van der Hulst 2000) we have to turn to weight-sensitive systems.[20]

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

18 Instead of deleting the 'losers', one could also instead promote the winner (with an extra grid mark). 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 exceptions 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.

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**)]	d. (σ σ)]	e.g. Epena Pedee
			Sel: right	Def: left	
	x	x	~~x~~ x	x	
ii.	a. (**σ** σ)]	b. (σ **σ**)]	c. (**σ** **σ**)]	d. (σ σ)]	e.g. Yapese
			Sel: right	Def: right	
	x	x	x ~~x~~	x	
iii.	a. (**σ** σ)]	b. (σ **σ**)]	c. (**σ** **σ**)]	d. (σ σ)]	e.g. Sunda
			Sel: left	Def: left	
	x	x	x ~~x~~	x	
iv.	a. (**σ** σ)]	b. (σ **σ**)]	c. (**σ** **σ**)]	d. (σ σ)]	e.g. Aklan
			Sel: left	Def: right	

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**)	d. [(σ σ)	e.g. Capanahua
			Sel: right	Def: left	
	x	x	~~x~~ x	x	
ii.	a. [(**σ** σ)	b. [(σ **σ**)	c. [(**σ** **σ**)	d. [(σ σ)	e.g. Archi
			Sel: right	Def: right	
	x	x	x ~~x~~	x	
iii.	a. [(**σ** σ)	b. [(σ **σ**)	c. [(**σ** **σ**)	d. [(σ σ)	e.g. Malayalam
			Sel: left	Def: left	
	x	x	x ~~x~~	x	
iv.	a. [(**σ** σ)	b. [(σ **σ**)	c. [(**σ** **σ**)	d. [(σ σ)	e.g. Ossetic
			Sel: left	Def: right	

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.

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 fn.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: 296-99). 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	$\cancel{x}\quad x$	Def: left	x
	$\sigma\ \sigma\ \boldsymbol{\sigma}\ \sigma\ \underline{\boldsymbol{\sigma}}\ \sigma\ \sigma\ \sigma$		$\underline{\sigma}\ \sigma\ \sigma\ \sigma\ \sigma\ \sigma$

21 In such systems accents instead if 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
$$\begin{array}{cccccccc} & & \cancel{x} & & x & & & \\ \sigma & \sigma & \boldsymbol{\sigma} & \sigma & \underline{\boldsymbol{\sigma}} & \sigma & \sigma & \sigma \end{array}$$
Def: right
$$\begin{array}{cccccc} & & & & & x \\ \sigma & \sigma & \sigma & \sigma & \sigma & \underline{\sigma} \end{array}$$

FIRST/LAST

Sel: left
$$\begin{array}{cccccccc} & & x & & \cancel{x} & & & \\ \sigma & \sigma & \boldsymbol{\sigma} & \sigma & \underline{\boldsymbol{\sigma}} & \sigma & \sigma & \sigma \end{array}$$
Def: right
$$\begin{array}{cccccc} & & & & & x \\ \sigma & \sigma & \sigma & \sigma & \sigma & \underline{\sigma} \end{array}$$

FIRST/FIRST

Sel: left
$$\begin{array}{cccccccc} & & x & & \cancel{x} & & & \\ \sigma & \sigma & \boldsymbol{\sigma} & \sigma & \underline{\boldsymbol{\sigma}} & \sigma & \sigma & \sigma \end{array}$$
Def: left
$$\begin{array}{cccccc} x & & & & & \\ \underline{\sigma} & \sigma & \sigma & \sigma & \sigma & \sigma \end{array}$$

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 such 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' (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.

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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 version of metrical theory, primary stress is built on the basis of rhythm, rather than vice versa. Additionally, and granted that the Idsardi theory builds constituency, it would seem that the model proposed here is much simpler, while accounting for the same array of stress systems.

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 a 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 a). 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 a), 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 next 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 language.[25] The logical possibilities for non-accentual languages are summarized in (24).

3.4 Why stress-accent languages do not have unaccented words

23 See Hyman (this volume) for a critical discussion of the notion accent.
24 Such cases may give rise 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.
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).

In van der Hulst (2011a, 2012) I show that unlike stress, accent is neither necessarily obligatory nor necessarily cumulative. 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 language), as long as there is a contrast between H and L 'tone' only. It would seem, however, that in stress-accent language, 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. Firstly, such languages may simply lack accent and only have utterance level (possibly weight-sensitive) rhythm. Secondly, in such languages words may be divided into several separate accentual domains each with their own stress-accent.

4 The rhythm module

4.1 Systems without rhythm (but with the option of weight)

We established earlier that rhythmic alternation is *not* mentioned 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.

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 isn't very likely to be sensitive to it. I sympathize with the spirit of this suggestion. It would be alright 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 patterns:

(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.

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.)

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 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:

(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 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 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.

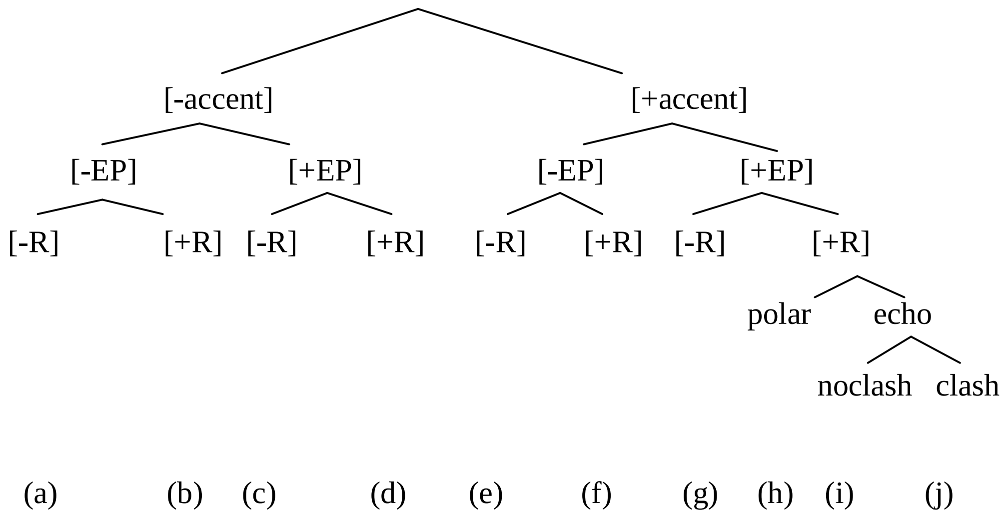
I conclude this section with a typology which displays the systems in terms of presence or absent of accent, polar edge prominence and rhythm:

(24)

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 grid mark. Recall that, for easy of presentation, I am not including such an extra mark in the figures.

29 Gordon (2002) refers to these systems as *dual systems* while Kager (2005a,b) and others use the term *bidirectional systems*.



(a) Non-accentual system without edge prominence or rhythm (section 3.3)
(b) Non-accentual system with rhythm only (section 3.3)
(c) Non-accentual system with edge prominence without rhythm (section 3.3)
(d) Non-accentual system with edge prominence and rhythm (section 3.3)

(e) Unidirectional accentual system without rhythm (section 4.1)
(f) Unidirectional accentual system with echo rhythm (section 4.3)

(g) Bidirectional accentual system without rhythm (section 4.4)
(h) Bidirectional accentual systems with polar rhythm (section 4.4)
(i) Bidirectional accentual systems with echo rhythm and no clash (section 4.4)
(j) Bidirectional accentual systems with echo rhythm and clash (section 4.5)

In section 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. In subsequent sections I will discuss the possibilities for rhythmic patterns in accentual systems.

4.3 Rhythm in unidirectional systems

4.3.1 Weight-insensitive systems

In Gordon (2002) a survey is reported containing 54 weight-insensitive languages. Two of these display a clash (Gibwa and Biangai). I return to systems of this sort in section 4.5.[30] In (25) I list the possibilities showing the number of times each case is attested in

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 4.5.

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 to Pintupi, the latter allowing a final lapse in odd parity words. This means 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	x	x	x
$(\Sigma\sigma)\underline{\sigma}\sigma\underline{\sigma}\sigma\underline{\sigma}\sigma$	$(\Sigma\sigma)\underline{\sigma}\sigma\underline{\sigma}\sigma\underline{\sigma}\sigma$	$\underline{\sigma}\sigma\underline{\sigma}\sigma\underline{\sigma}\sigma(\Sigma\sigma)$	$\sigma\sigma\underline{\sigma}\sigma\underline{\sigma}\sigma(\Sigma\sigma)$
x x x x	x x x x	x x x x	x x x
x	x	x	x
$(\Sigma\sigma)\underline{\sigma}\sigma\underline{\sigma}\sigma\sigma$	$(\Sigma\sigma)\underline{\sigma}\sigma\underline{\sigma}\sigma\underline{\sigma}$	$\sigma\underline{\sigma}\sigma\underline{\sigma}\sigma(\Sigma\sigma)$	$\sigma\underline{\sigma}\sigma\underline{\sigma}\sigma(\Sigma\sigma)$

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 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 as often based on one word utterances; see de Lacy (this volume) and Gordon (this volume).

33 The unattested case in (25c) is what Hermans (2011) calls ‘anti-Pintupi’.

34 The obligaroriness 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 illformed) in section 3.4.

x x x	x x x x	x x x	x x x
Pintupi (14)	Murinbara (18)	Warao (12)	Unattested

Iambic (9)

c. LR (4)		d. RL (5)	
x	x	x	x
$(\sigma\Sigma)\sigma\underline{\sigma}\sigma\underline{\sigma}\sigma\underline{\sigma}\sigma$	$(\sigma\Sigma)\sigma\underline{\sigma}\sigma\underline{\sigma}\sigma$	$\sigma\underline{\sigma}\sigma\underline{\sigma}(\sigma\Sigma)$	$\sigma\underline{\sigma}\sigma\underline{\sigma}\sigma\underline{\sigma}(\sigma\Sigma)$
x x x x	x x x	x x x	x x x x
x	x	x	x
$(\sigma\Sigma)\sigma\underline{\sigma}\sigma\underline{\sigma}\sigma\underline{\sigma}$	$(\sigma\Sigma)\sigma\underline{\sigma}\sigma\underline{\sigma}\sigma\sigma$	$\sigma\sigma\underline{\sigma}\sigma\underline{\sigma}(\sigma\Sigma)$	$\underline{\sigma}\sigma\underline{\sigma}\sigma\underline{\sigma}(\sigma\Sigma)$
x x x x	x x x	x x x	x x x x
Araucanian (3)	[Hixkaryana]	unattested (0)	Weri (5)

The question must now be asked 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)

$$\sigma \Rightarrow \overset{x}{\sigma}$$

Firstly, 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)

$$\sigma\ \ \sigma \Rightarrow \overset{x}{\sigma}\ \ \sigma$$

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

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.

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 futher, 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).

Secondly, 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 the 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 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

Even-parity	Odd-parity	
$(\Sigma\sigma)\ \underline{\sigma}\sigma\ \underline{\sigma}\sigma\ \underline{\sigma}\sigma$	$(\Sigma\sigma)\ \underline{\sigma}\sigma\ \underline{\sigma}\sigma\ \underline{\sigma}$	
x x x x	x x x [x]	Final fill out (y/n)

b. Penultimate accent: trochaic rhythm

Even-parity	Odd-parity	
$\underline{\sigma}\sigma\ \underline{\sigma}\sigma\ \underline{\sigma}\sigma\ (\Sigma\sigma)$	$\sigma\underline{\sigma}\ \sigma\underline{\sigma}\ \sigma\ (\Sigma\sigma)$	
x x x x	x x x	

c. Peninitial accent: iambic rhythm

Even-parity	Odd-parity	
$(\sigma\Sigma)\ \sigma\underline{\sigma}\ \sigma\underline{\sigma}\ \sigma\underline{\sigma}$	$(\sigma\Sigma)\ \sigma\underline{\sigma}\ \sigma\underline{\sigma}\ \sigma$	
x x x [x]	x x x	Final fill-out (y/n)

d. Final accent: iambic rhythm

Even-parity	Odd-parity	
$\sigma\underline{\sigma}\ \sigma\underline{\sigma}\ \sigma\underline{\sigma}\ (\sigma\Sigma)$	$\underline{\sigma}\ \sigma\underline{\sigma}\ \sigma\underline{\sigma}\ (\sigma\Sigma)$	
x x x x	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
	+ Non-finality (y/n)	+ Final fill-out (y/n)	+ Initial Fill out
			+ Final Fill out (y/n)

Given that Theory C is more complex than both other 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 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		
	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 gives 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 from 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) Beat addition

				x		
σ	σ	σ	⇒	σ	σ	σ

Here, given the scarcity of data 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) Beat addition

				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 4 syllable lapse. In Theory A, this situation is prohibited given the definition of clash. 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 article, 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 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).

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 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).

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 system is how precisely beat addition interacts with heavy syllables. Again I will compare the three different theories in (29). The following table spells out which rhythmic patterns have been attested:[39]

(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 (case 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 (case 37c). The reverse is found in Cahuilla (cases 37b and d). Taken at face value, this difference suggests the copy theory of rhythm (Theory C) if we adopt the following copying table:

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 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.
40 Hayes (1995) analyses the languages in this table: Menomini (218-221), Cahuilla (pp. 132-140), Fijian (142-149), each of which have the patterns in table (37), which is not to say that these patterns embody full descriptions of the stress system of these languages.

(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 table (37) by the more explicit table in (39), this time putting in foot boundaries, assuming the asymmetric foot theory of Hayes (1995):

(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]

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 (p. 265-6). Kager (1993) explains the total absence of RL iambic weight-sensitive feet[41] with reference to *Backward Clash*

41 In Kager's theory the weight-sensitive iambic foot is a moraic foot, replacing Hayes' unbalanced foot type (which allows a light-heavy sequence), but that does not affect the present discussion.

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 it is assumed, as Kager points out, that heavy syllables have an inherent '(x.)' pattern, branching rhymes being left-headed:

(40)	σ	σ	$[\mu\mu]_{\sigma}$	$\underline{\sigma}$	σ	σ
			x	x		

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) must be 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 simple, 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 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) analyses 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)	$([\mu\mu]_{\sigma})$ σ	σ	σ		(=35a)
			x	x				
	b.	σ	(σ	$[\mu\mu]_{\sigma})$ (σ	σ)	σ		(=35c)
				x	x			
(42)	Cahuilla							
	a.	(σ	σ)	$([\mu\mu]_{\sigma})$ σ	σ	σ		(=35a)
		x		x				
	b.	σ	(σ	$[\mu\mu]_{\sigma})$ (σ	σ)	σ		(=35c)
				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]$_σ$ [μμ]$_σ$ σ σ σ (=41a after lengthening)

(43)	σ	[μμ]$_σ$	[μμ]$_σ$	σ	σ	σ
		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

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' 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, 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 and 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.

(47) Theory A or B

	LR	RL
Syllabic	Forward Clash allowed	No clash
Moraic	No clash	No clash

The question might be raised *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' to 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 over Theory C because the latter theory leaves an unexplained gap:

(48) Theory C

	LR	RL
Iambic	Forward Clash allowed	No clash [gap]
Trochaic	No clash	No clash

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):

42 An objection against a total dismissal of the iambic/trochaic distinctions 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

(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.

4.4 Rhythm in bidirectional systems

In section 2, I mentioned that rhythmic languages may have either echo or 'polar' rhythm. The difference was illustrated in section 2 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]

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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.

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

Kager (1991, 2001, 2005a,b), Gordon (2002), Alber (2005), Hyde (2008), Houghton (2008) all discuss discusses bidirectional systems within the context 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 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,b) we find a (preliminary) typology of bidirectional systems:

(51) Bidirectional systems

a. <u>Weight-insensitive trochaic systems</u>[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. <u>Weight-insensitive iambic systems</u>

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 2005ab, Hermans 2011, Hyde, this volume). Kager proposes to rule out all systems in the second and third column in (51a and b). In each of these cases we have a medial lapse that is *not* adjacent to the primary

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(σ)	<u>(σ</u>	<u>σ)</u>	(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.

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'.

stress and Kager proposes a constraint that prohibits precisely this. The first two cases in the iambic row (in 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 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 (1993) and Hualde and Nadeu (this volume):

(52) Colloquial pattern: σ̀σσσ̀σσ́σ (bidirectional, with an initial dactyl)

Rethorical pattern: σσ̀σσ̀σσ́σ (unidirectional)

Given the possibility of the colloquial pattern, the question arises 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 shift a beat to the initial syllable when odd number of syllables preceded the stress-accented syllable. Here, as indicated in section 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 accent, either departing from the polar beat (as in Piro) or from the accent (as in Spanish). This proposal not only allows us to adopt Theory A, 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 directional systems that have been mentioned in Kager (1991, 2001, 2005a,b), Gordon (2002), Alber (2005), Hyde (2008) and Houghton (2008). This list firstly 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*	Walmatjarri* Mingrelian*

48 Walmatjarri* reportedly has two patterns: the non-primary beat can also be on the APU syllable.

		Gugu Yalanji	
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*****	-	-

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] A 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]

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 Bipolarisation Principle (BPP) and the Accentual Hierarchisation Principle (AHP). The BPP 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 (2011), 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. Firstly, when there is rhythm, the first polar beat is generally described as being stronger than the intervening rhythmic beats. This suggest 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 both 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:

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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 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.

(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 stresses. 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 2011).

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 or final 'trochaic' '(x.)' accent domain (allowing for Extrametricality in the case 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 it 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 (57a), 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.

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 $(\Sigma\sigma)\underline{\sigma}\sigma\underline{\sigma\sigma}$	b. Biangai[51] $\underline{\sigma\sigma}\sigma\underline{\sigma}\sigma(\Sigma\sigma)$
Iamb	c. Gibwa $(\sigma\Sigma)\sigma\underline{\sigma}\sigma\underline{\sigma\sigma}$	d. Tauya $\underline{\sigma\sigma}\sigma\underline{\sigma}(\sigma\Sigma)$

None of these cases are discussed in Hayes (1995), but he does report that Southern Paiute which has 2nd syllable accent and rightward rhythm does not have a final beat in words with an even number of syllables and instead has a beat on the penultimate syllable, which creates a clash between the antepenultimate and penultimate syllable. 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 $(\sigma\Sigma)\sigma\underline{\sigma}\sigma\underline{\sigma\sigma}\sigma$	Not attested $\sigma\underline{\sigma\sigma}\sigma\underline{\sigma}\sigma(\Sigma\sigma)$

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
```

51 A reviewer notes that Passamaquoddy, Maithili and South Conchucos Quechua also have the 'Biangai' pattern.

The final beat cannot be accounted for in terms of foot assignment in even numbered words, so my suggestion is (following Moskal 2011) 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	

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.

Thirdly, we turn to case in (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.mìn ‘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.

Fourthly, we discuss case (59d):

(65) Tauya (MacDonald 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 misanalysed 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.

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, this 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 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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