Word Stress: Theoretical Approaches

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Key Points

- Providing a review of (representational) theories of word stress
- Critically examining the ordering of the assigning of primary and nonprimary stress
- Presenting a primary stress first model

Abstract

This article reviews a number of different formal theories for the representation of word stress.

Introduction

This article discusses a number of formal approaches to word stress, focusing on the so-called Metrical Theory that differs from all preceding work on word stress, not only in terms of stress representations, but also by offering a comprehensive and explicit theoretical account of the diversity of word stress systems. I will discuss its original motivation and scope, how it extended its empirical domain, which changes it underwent, and what the current situation is. Since we deal with a theory that was introduced more than thirty years ago, it would be easy to write a whole book on this topic. In this article, I will have to limit myself to a selection of proposals (and references) that, in my view, are representative of crucial developments in the metrical theory. I will not present a strict historical overview, but rather organize the discussion around various aspects of the theory, such as the central principles and notations, as well as the most important theoretical developments.

A basic idea underlying metrical theory is that primary stress assignment is based on the prior assignment of rhythmic stress. After having reviewed metrical theory, I will turn to an alternative theory which is based on a different understanding that the assignment of rhythmic stress follows the assignment of primary stress.

The stress theories discussed in this article are designed to account for word stress patterns that apply within a domain that is either morphologically underived, or derived in terms of affixes which create morphological structure that is invisible to the stress rules. Also, I will limit my attention to the word domain and thus not deal with larger units such as phrases and sentence structure. I will here not discuss whether domains for stress are morphosyntactic or prosodic, nor the mapping between these domains (cf. Inkelas & Zec 1990; Nespor & Vogel, 1986; Selkirk, 1980); see Article 'Stress Typology'.

Stress in The Sound Pattern of English

In Chomsky and Halle (1968), an extensive analysis of English 'word stress' is proposed which appeals to two rules, the Main Stress Rule (MSR) and the 'alternator'. The MSR produces a stress on the final, penultimate or antepenultimate syllable, while the

alternator produces an alternating pattern of secondary stresses that precede the main stress. In addition, primary stress can be retracted (i.e. move leftward) under certain conditions. In a sense, Sound Pattern of English (SPE) proposed a 'primary stress first approach'. Liberman and Prince (1977, p. 278) propose an updated version of the SPE system that conflates the original MSR and the alternator:

(1) English stress rule. Iterative version

$$V \rightarrow [+\text{stress}] / ___ \; C_0 \, (V(C))_a \, (V \, C_0)_b \quad (V \, X)_c \, \# \\ \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad <-\text{long}> \; [+\text{stress}]$$

Conditions: $\neg$ c $\supset$ d; $\neg$a, $\neg$b under certain morphological and lexical circumstances

This rule has various expansions. Its shorter expansions (the ones that do not mention the [+stress] environment) are responsible for the assignment of the primary stress, while the longer expansion accounts for the alternating stresses that precede the primary (rightmost) stress. My concern is here not with the precise formalism which clearly reflects the SPE-style rule format, including many of its notational devices. We do need to note, however, that while in this SPE tradition primary and secondary stress assignment are part and parcel of the same rule, it is still the case that primary stress assignment takes priority over placing alternating stresses because, as per SPE conventions, shorter expansions of a rule apply before longer expansions. The ordering of assigning primary and nonprimary stress will be critically examined in section **Primary Stress First Theory**.

Metrical Phonology

Metrical theory was first developed in Liberman (1975). His thesis primarily deals with the intonational system of English, but Liberman included a new proposal for the representation of English word stress in his work. The theory in its initial form is best known from Liberman and Prince (1977).

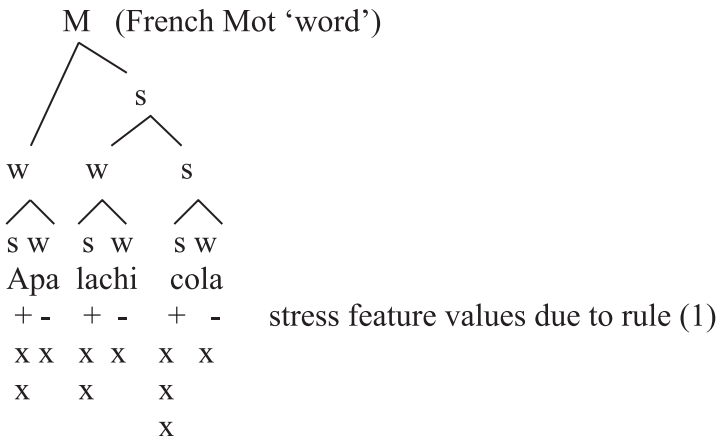
Having noted the correspondences between metrical patterns of verse lines and the stress pattern of words, Liberman (1975) proposes to analyze the latter in terms of the concept that is basic to the former: the metrical *foot*. Liberman's basic insight is that the edge preference of primary stress and the alternating character of nonprimary stresses simply follow as necessary properties if stress patterns are represented by first assigning feet throughout the word (which group together the syllables of words), and then assigning head status to the stress of the leftmost or rightmost foot to derive the primary stress.

In the approach offered by Liberman and Prince, the SPE rules were not abandoned. As before, word stress was assigned to vowels by a modified version of the SPE MSR, shown in (1). The novelty was that the string of segments with stress assignments was now fed into an algorithm that parsed it into a metrical constituent structure (as in (2)). This structure was called *metrical* because of the central role of the foot.

The metrical algorithm that Liberman and Prince introduced first added to the syllabified string a layer of bisyllabic constituents (feet). Secondly, the feet were organized into a binary branching 'word' tree. The resulting tree structure was augmented with the labels "Strong" and "Weak". At the foot level, the S label was assigned to syllables that contained a stressed vowel. At the word level, right-branching trees were labeled WS and left-branching trees SW:

(2) a. Every sequence of syllables with stress value +-, +– etc. forms a metrical tree (i.e. a foot). The feet are organized into a right branching tree, labeled WS:

b.



In summary, *Metrical Theory* formalizes the correspondence between primary and secondary stress by proposing that the string of syllables of a word is organized in a sequence of binary left-strong feet (called *trochaic feet*). The sequence of feet is then organized into a binary right-branching structure that designates the rightmost foot as the strongest foot in the word because each pair of sister-nodes in the 'word tree' is labeled W S. As we will see in section **Developments of Metrical Theory**, the grouping of syllables into feet is directional, going from right-left or left-to-right. When the number of syllables is even, as in example (2), you cannot tell what the direction is. Also, while in the example given the word tree is right-branching, we will see in section **Developments of Metrical Theory** that in other languages the tree structure can be left-branching.

As shown in (2), in addition to the metrical tree structure, Liberman and Prince postulated a second structure composed of x's, called the *metrical grid*. This grid, that represents *relative prominence* without constituency, can be 'read off' from the tree according to the algorithm in (3):

(3) In any constituent the strong daughter has a higher grid column than its weak sister

Why we would need the grid in addition to the tree (or why not) will be discussed further below.

The terms *strong* and *weak* suggest that stress is taken to be a relative notion. A syllable is said to be 'strong' by virtue of being more prominent than a sister syllable. However, a syllable by itself (e.g. in a monosyllabic word) can also be said to be stressed. In this way, one can make a difference between stressed monosyllabic words and unstressed monosyllabic words, the latter often called (phonological) clitics. This suggests a nonrelative view on stress, adopted in Selkirk (1980) who replaced the terms strong and weak by the terms *head* and *dependent*. Selkirk also proposed to do away with the SPE stress rules and make the metrical tree-building algorithm directly responsible for assigning stress. The conditions that formerly specified which vowels would receive the value [+stress] now were restated as conditions on which vowels could be heads of feet. Selkirk's proposal implied that the feature [stress] was no longer needed.

Feet can be defined as binary branching headed constituents, thus restricted to two terminal daughters (syllables); we call such constituents *bounded*. The tree structure that organizes the feet is also thought of as binary branching, but it is *not* bounded because it can contain more than two terminals, for example, in (2) it contains *three* feet. All pairs of sister nodes enter into a head-dependency relationship.[1]

Why is the structure in (2) an adequate representation of the stress pattern of *Apalachicola*? Notice, firstly, that only one syllable can be exclusively dominated by nodes labeled S (and the root node, labeled M). This syllable, then, is the *ultimate head* of the word and that seems to be an adequate formal representation of the culminative nature of primary stress. Clearly, there can be only one ultimate head in this notation for each domain. Secondly, secondary stresses are uniformly represented as heads of feet so that we can now say that all heads are stressed. What about different degrees of stress? To speakers of English, the nonprimary stress on the first syllable is stronger than the nonprimary stress on the third syllable (which is sometimes called a tertiary stress). Does this mean that (2) is not an adequate representation of the stress pattern? It would be, if we assume an additional grid building rule which assigns an extra grid mark to the first column, while at the same time adding a grid mark to the rightmost column. Indeed, one motivation for having both the tree and the grid was that the latter structure could be subject to 'beat' addition rules that do not impact the tree structure.

However, Liberman and Prince did not only motivate the need for a grid with reference to beat addition, they also appealed to the notion of 'beat movement'. Their notorious example involves the following phrase:[2]

(4)

thirteen	men
x x	x
x	**x**
	x

The two bold grid marks constitute a *clash*, which is rhythmically undesirable. What we actually find in English is:

(5)

thirteen	men
x x	x
x	**x**
	x

[1]The core of metrical phonology was already around before Liberman and Prince proposed their very influential ideas. Liberman and Prince (1977) were apparently unaware of Dependency Phonology that emerged in the early 1970s (see Anderson & Ewen, 1987), but they do mention that the idea that relative salience relations can be seen as a side-effect of grouping was independently suggested in Garde (1968) and Rischel (1982).
[2]The bold grid marks represent compound stress and the highest grid mark represents phrasal stress.

It would seem that one of the first bold grid mark has 'moved'. The movement rule is called the *rhythm rule*, or *rhythmic reversal*. I refer to Visch (1999) for an extensive study of such rules.

In conclusion, it seems to be the case that the grid is needed in addition to the tree because it is in this structure that we can clearly identify and rectify stress lapses and stress clashes. However, not everyone accepted the conclusion that 'metrical dualism' was inevitable. As is well known, dualism can be substituted for by two forms of monism, in this case arboreal monism (trees only) or rhythmic monism (grids only). I will first consider arboreal monism.

First Kiparsky (1979) showed that the rules that had motivated the grid in terms of clash avoidance could also be reformulated with reference to the tree structure alone. He argued that the tree configuration for *thirteen men* triggers a *metrical transformation* that involves relabeling:

(6)

His argument that relabeling could remedy clashes was generally accepted. Giegerich (1985) then provided a method for replacing beat addition by other types of arboreal transformations.

Prince (1983) went the other way in rejecting metrical dualism: he proposed to do away with the trees. In order to build grids from scratch, he formulated *grid construction rules*, which mimic the formation of trees. Foot formation was replaced by 'Perfect Gridding' (PG) and word tree formation was replaced by the 'End Rule' (ER):

(7)

a	pa	la	chi	co	la	
x	x	x	x	x	x	
x		x		x		PG
				x		ER (R)

The essential difference between the grid only theory and the tree only theory is that the former lacks the notion of *grouping*. In (7), the syllable /pa/ bears no relation to either /a/ or /la/, whereas it is a sister of /la/ in the tree approach. Prince's reasoning was that, if grouping is not crucially needed, the grid by itself offers a more economical representation of stress. The crucial question here is: do we need the foot domain? Even though Prince had argued that reference to the foot can be replaced by reference to grid columns, Halle and Vergnaud (1987), Idsardi (1992) and Kenstowicz (1993) showed that Prince's proposal was the wrong way to go because they argued that foot constituency *is* necessary.

To please all parties, Halle and Vergnaud (1987) adopt a notation that uses the grid enriched with brackets to indicate constituency. This is called the bracketed grid notation, which is really a notational variant of a tree structure:

(8)

a	pa	la	chi	co	la	
(x	x)	(x	x)	(x	x)	
(x		x		x	)	foot formation
				x		word tree (flat)

However, note that the grid in (8) does not express the fact that the first syllable has the strongest nonprimary stress. This means that the bracketed grid must be enriched with a further level to indicate this:

(9)

a	pa	la	chi	co	la
(x	x)	(x	x)	(x	x)
(x		x		x	)
(x				x	)
				x	

The bracketed grid notation was further developed in Idsardi (1992). Henceforth, in discussing the workings of metrical theory, I will use the bracketed grid notation that was proposed in Halle and Vergnaud (1987).

Developments of Metrical Theory

Bounded Stress Systems

In 1978, a very important (never published) paper came into circulation: Jean-Roger Vergnaud and Morris Halle: *Metrical Phonology: A fragment of a draft*. The importance of this paper lies in transforming the Liberman and Prince theory of English stress into a *parametric* theory of stress systems in general. The Liberman and Prince analysis of English involved a particular algorithm for foot and word formation, which, as Vergnaud and Halle show, can be seen as just one member of a family of algorithms. Halle and Vergnaud showed that other algorithms would involve the same type of left-headed, trochaic foot, but assigned from left to right, or a right-headed, iambic foot type. Furthermore, as already anticipated, feet could be assigned in either direction and the word tree could be left-headed in one language and right-headed in another.

Each step in the algorithm was taken to be an "off/on", "left/right" or "yes/no" parameter.

(10)		
	a.	Foot type: left-headed/right-headed
	b.	Direction: left-to-right/right-to-left
	c.	Word tree: left-headed/right-headed[3]

These three parameters allow for 8 possible word stress systems. The four possibilities in (11) assign head status to the foot that comes first (i.e. leftmost in left-to-right, and rightmost in right-to-left parsing). This correlation between directionality of foot assignment and primary stress location is typical. However, in (12), this correlation is not present: primary stress falls on the last foot that has been assigned, instead of, as is usual, on the first foot that is assigned. I have called such systems *count systems* because we must necessarily group all syllables into feet before we can know where primary stress is located. I will return to the difference between count and noncount systems in section **Primary Stress First Theory**.

(11)

		Odd	Even
a.	Word(LH)	x	x
	Foot(LH,LR)	(x x x)	(x x x)
		(σσ)(σσ) (σ)	(σσ)(σσ)(σσ)
b.	Word(LH)	x	x
	Foot(RH,LR)	(x x x)	(x x x)
		(σσ)(σσ) (σ)	(σσ)(σσ)(σσ)
c.	Word(RH)	x	x
	Foot(LH,RL)	(x x x)	(x x x)
		(σ)(σσ)(σσ)	(σσ)(σσ)(σσ)
d.	Word(RH)	x	x
	Foot(RH,RL)	(x x x)	(x x x)
		(σ)(σσ)(σσ)	(σσ)(σσ)(σσ)

(Continued)

[3]It is here assumed that right-headed word trees are right-branching and vice versa.

—cont'd

(12)

		Odd	Even
a.	Word(RH)	x	x
	Foot(LH,LR)	(x x x)	(x x x)
		(σσ)(σσ) (σ)	(σσ)(σσ)(σσ)
b.	Word(RH)	x	x
	Foot(RH,LR)	(x x x)	(x x x)
		(σσ)(σσ) (σ)	(σσ)(σσ)(σσ)
c.	Word(LH)	x	x
	Foot(LH,RL)	(x x x)	(x x x)
		(σ)(σσ)(σσ)	(σσ)(σσ)(σσ)
d.	Word(RH	x	x
	Foot(RH,RL)	(x x x)	(x x x)
		(σ)(σσ)(σσ)	(σσ)(σσ)(σσ)

In words that have an odd number of syllables there will always be one peripheral syllable that ends up being a foot by itself. We refer to a foot that would consist of a single (light) syllable as *degenerate* or *unary*. It has been claimed that a single syllable cannot form a foot by itself and thus should remain unparsed. We will say that when a single syllable is not parsed it is "trapped" (cf. Mester, 1993) or "stranded". Allowing trapped syllables implies that we do not require foot parsing to be exhaustive. Exactly how trapped syllables are incorporated into the metrical structure is an open issue. Allowing unary feet can lead to clashes as in several cases in (11) and (12). Such clashes are sometimes resolved by removing one of the beats, as in (12c), for example, causing the initial three syllables to be grouped into a ternary dactylic foot. This happens in the language Garawa (Australian; Furby, 1974):

(13) Initial Dactyl Effect

x		x
x x x	⇒	x x
(σ)(σσ)(σσ)		(σσσ)(σσ)

Vergnaud and Halle discovered that the word stress rules of a great variety of languages could be "unraveled" and represented in terms of settings for these parameters. Their proposals were elaborated and richly documented in a 1980 MIT dissertation by Bruce Hayes. I will now motivate that we need a few additional parameters and then we will discuss some of the theoretical developments that have taken place since the early eighties.

Extrametricality

There are languages which have a primary stress on the *antepenultimate* syllable; see Article 'Stress Typology'. One might argue that in these cases stress location is the result of assigning a left-headed *ternary* foot, i.e. a dactyl at the right edge of the word:

(14)

	x
...	x)
	σσσ(σσσ)

Another way to deal with antepenultimate stress is to mark the final syllable as *extrametrical*. The extrametrical syllable is put between angled brackets in metrical illustrations:

(15)

```
        x
   (    x    )
σ(σσ)<σ>
```

In Latin [Romance; Mester, 1993], stress is antepenultimate or penultimate depending on the weight of the penultimate syllable, but it is never on the final syllable, whatever its weight syllable. It is apparently the case that to establish the right-edge stress window, the rightmost syllable of words can be 'ignored', which is a clear case of *extrametricality*.

The possibility of extrametricality is a parameter that has a subparameter because, if it applies, we have to know whether it applies on the left or right edge of the word:

(16)

Extrametricality parameter
Extrametricality: yes/no
If yes: left/right

Adding this parameter raises the number of possible stress system from 8 to 24.

Once extrametricality has been recognized as a formal device which may be part of the overall stress recipe, we may also entertain the idea that it is used lexically, i.e. as a mechanism for marking exceptions, for example, in a language that has regular final stress, but some exceptions with penultimate stress.

If extrametricality can apply on either word edge, we would expect to find languages that have third syllable stress. This pattern, however, is very rare and the idea has been around that extrametricality should be limited to the right edge. This route is chosen by Prince and Smolensky (1993), who rename extrametricality as *nonfinality*. However, left-edge extrametricality seems necessary in some cases; see Article 'Stress Typology'.

Weight Sensitivity

We now turn to a factor that may influence the way in which syllables are gathered into feet. So far, we assumed that syllables are gathered in groups of two syllables, monosyllabic feet arising only (but not necessarily) in words that have an odd number of syllables. In some languages, however, certain types of syllables (called heavy) may not appear as the dependent daughter in a foot. This is called *weight sensitivity*. The 'weight' of a syllable is determined by its intrinsic, phonological properties. There are various types of intrinsic properties that can cause a syllable to be heavy:

(17)

heavy	*light*
long vowel	short vowel
closed syllable	open syllable
low vowel	non-low vowel
high-toned vowel	low-toned vowel
full vowel	reduced vowel

The first two types have also been called *moraic weight*, assuming that in each of these cases the heavy syllables contain two units in their syllable rhyme; these units are called moras (or weight-units). In the remaining three cases, the heavy syllable is more salient by virtue of its greater aperture, its higher pitch, or its more complex articulation. This kind of weight has also been called 'prominence' (Kenstowicz, 1997).

The assignment of feet can also be influenced by lexical irregularity. Thus, for example, in Polish, which has weight-insensitive penultimate primary stress, some words have irregular final or antepenultimate stress. How can we account for that? The answer is that irregular final stress can be achieved by assigning a lexical mark to the final syllable, and adding the convention that syllables with such marks may not appear in the dependent position of the foot. We can refer to such marks as 'diacritic weight'. Such marks usually are historical residues of an earlier situation in which the relevant syllables had intrinsic weight. If a language that has regular penultimate stress has some words that have antepenultimate stress, we can also use extrametricality as a lexical device for such words.

To accommodate weight sensitivity, we need a parameter which can be set to yes or no. If set to yes, this means a heavy syllable cannot occur in the dependent position of a foot.

To illustrate the effect of weight sensitivity, let us consider a right-edge system with left-headed feet, assigned right-to-left. Four configurations may occur with respect to the rightmost two syllables:

(18)	h l]	l l]	h h]	l h]

The square brackets represent the morphological word boundary; "h" and "l" represent heavy and light syllables. The first and second case present no problem since we can simply assign a binary trochaic foot without violating the weight condition which prevents a heavy syllable from occurring in the dependent foot position. It is important to bear in mind that this condition only bans heavy syllables from dependent position. It does not bar light syllables from head position:

(19)	x (h l)]	x (l l)]	*x (h h)]	*x (l h)]

The problem lies in the other two cases. Clearly, if weight is to be respected, we cannot assign a trochaic foot over the two word-final syllables, as we did in (19), because a heavy syllable would then end up in the weak position of the foot. What we can do, however, is assign a *monosyllabic* foot to the final syllable:

(20)	x (h l)]	x (l l)]	x h (h)]	x l (h)]

In these two cases, the heavy syllable forms a foot by itself. The structures in (20) are appropriate for a system which has primary stress on the final syllable if this is heavy and on the penultimate syllable otherwise, as in Rotuman (Austronesian; Churchward, 1940).

The parameter of weight sensitivity, when added to the three parameters we already had, leads to increasing the set of possible stress systems from 24 to 48.

NonIterative Footing

In (20), we only considered the assignment of one foot on the right or left edge in weight-sensitive systems. Of course, in metrical theory feet are assigned *iteratively* to account for rhythmic patterns. However, in some versions of metrical theory, it has been proposed that iterativity is itself a parameter to account for languages that show no evidence for rhythmic patterns throughout the word.

Here, I will not exemplify the assignment of foot structure throughout the word in weight-sensitive systems. Hayes (1980, 1995) provides many examples that are relevant here. At this point, I merely wish to assert that weight sensitivity often plays a role in foot assignment throughout the word domain, not just with reference to the foot that carries the primary stress.

Changing the Foot Inventory

In accordance with the parameters on foot form and foot type, we have postulated four foot types. However, Hayes (1986, 1995) reported that certain possibilities of the original parametric system are suspiciously rare, or, worse, produce unattested patterns:

(21)	Rare (or unattested) systems a. Weight-insensitive iambic feet (in either direction) b. Weight-sensitive trochaic feet (in either direction)

Hayes therefore proposes to eliminate the weight-insensitive iambic foot and to replace the weight-sensitive trochee by a so-called *moraic trochee*. A moraic trochee is a left-headed foot type that maximally contains two light (i.e. monomoraic) syllables or one heavy (i.e. bimoraic) syllable.

The cases that were represented in earlier works with the now abandoned foot types were thus in need of an alternative analysis. By allowing certain manipulations at the edges of stress domains (like excluding syllables from the parse by virtue of extrametricality) or postulating empty syllables (*catalexis*), such alternatives could usually be found. The reanalyses of course had to express the same prominence patterns but usually led to different constituent structures when compared to the original analyses.

The next step was taken by Kager (1989, 1993) who extended the bimoraic upper bound of moraic trochees in the iambic domain. He proposed that weight-sensitive iambic systems do not require (l h) feet and he suggested reanalyses for the few cases that were originally analyzed with such feet. Van de Vijver (1997) questions the existence of iambic feet in more radical terms, arguing for different ways of dealing with all former "iambic" systems. I refer to van der Hulst (1996) for a detailed comparison of the old and new versions of metrical theory. This article also discusses various proposals to deal with so-called ternary systems.

Unbounded Stress Systems

In systems discussed so far, primary stress cannot be further away from the edge than three syllables. The maximal distance of three syllables away from the word edge can be reached by applying extrametricality. The maximal domain within which stress can be located is often called 'the trisyllabic window'. Systems of this kind are called *bounded*. We now turn to so-called *unbounded systems*.

In unbounded systems, there is no trisyllabic window. Stress can occur anywhere in the word. A typical example is given in (22):

(22) Classical Arabic (McCarthy, 1979; Wright et al., 1967)
- Stress the rightmost nonfinal syllable that has a long vowel or closing consonant.
- If there are no such syllables, stress the first syllable.

There appear to be four types of unbounded systems:

(23)
First heavy or (if there is no heavy) last
Last heavy or (if there is no heavy) first
First heavy or (if there is no heavy) first
Last heavy or (if there is no heavy) last

Unbounded systems are remarkable systems, especially if one wants to argue that the function of stress is to provide pointers for word demarcation. In the original version of metrical theory, a parameter was used to distinguish bounded from unbounded systems in terms of distinguishing between bounded and unbounded feet. This approach is maintained in Halle and Vergnaud (1987). However, the idea that unbounded systems are foot based was abandoned by some other phonologists. For example, Hayes (1995) asserts that, because we have all the four logical possibilities, "there is little to constrain a theory". He rejects the approach that treats unbounded systems with unbounded feet, suggesting that we adopt a grid-only treatment along the following lines. We assign a beat to the leftmost or rightmost heavy syllable and then also state a default rule, with a left/right option which applies if there are no heavy syllables:

(24) Parameters for unbounded systems
a. Assign a grid mark to the leftmost/rightmost heavy syllable
b. Assign a grid mark to the leftmost/rightmost syllable

Prince (1985) analyzed unbounded systems in terms of bounded feet that were required to contain a heavy syllable which means that many light syllables would simply remain unparsed.

Optimality Theory

The bloom of metrical theory occurred throughout the 1980s. With the rise of optimality theory (OT) (Kager, 1999; Prince & Smolensky, 1993) in the early 1990s, we see an initial focus on some areas where OT appears to offer an advantage. The arena of stress phenomena seemed to display quite a few cases where constraint ranking is appealing. For example, in the case of syllable weight, we see the effect of a conflict between 'rhythmic regularity' (i.e. a regular alternation of strong and weak syllables) and prominence due to syllable weight. To say that weight-sensitive languages rank weight sensitivity over some other constraint that demands 'regular rhythmic grouping' seems appealing, although the pre-OT account that appeals to presence or absence of the weight constraint in the grammar works equally well. In fact, it is quite easy to restate all parametric work in terms of ranked constraints, which means that, from a formal point of view, the power of parametric accounts is included within the power of OT accounts. The power of OT is greater than that of a parametric theory, which means that OT predicts and handles systems that a parametric approach cannot (unless with additional ad hoc rules). A good introduction to OT, providing arguments of this kind, is Kager (1999). Applications of OT to a variety of stress systems can be found on the Rutgers Optimality Archive (ROA) website (https://roa.rutgers.edu/).

It is to be expected that OT analyses with their virtually limitless introduction of new constraints can deal with subtle or 'gradient' phenomena which fall outside the reach of the 'cruder' parametric approaches.

Primary Stress First Theory

In section **Developments of Metrical Theory**, I have mentioned the prevalent correlation between direction of footing and the edge at which the head foot (and thus primary stress) is located. In standard metrical theory, this correlation is an 'accident'. van der Hulst (1984) proposed that the correlation can be explained if we adopt a theory in which primary stress is assigned first and the footing that accounts for secondary stresses is literally secondary, with feet that account for rhythmic stresses being applied from right to left, if primary stress is on the left edge, and vice versa. This implies that separate statements are made about primary and nonprimary stresses and that, by convention, primary stress 'feet' are heads of words (This ordering of primary stress and rhythmic stress allows for bidirectional systems and systems that have a polar secondary stress; see Article 'Stress Typology').

In support of the independence of primary and nonprimary stresses van der Hulst & Goedemans (2014) document languages in which the foot type for each is different. Standard metrical theory did not adopt the idea of separating primary and nonprimary stresses. As we have seen, this model adopted a procedure which would first construct a layer of feet across the whole word, while then 'promoting' a left or right peripheral foot to head status of the word. Under this approach, differences between generalizations concerning primary and nonprimary stress would necessitate the formulation of adjustment rules of various kinds.

The idea to separate primary and nonprimary stress was first suggested in van der Hulst (1984) and developed in subsequent work (see below). Others (within metrical or other frameworks) have made similar suggestions (Harms, 1981; Hurch, 1992; Roca, 1986). A further development of this primary stress first approach was that primary stress assignment would typically apply lexically (which allows for lexical exceptions), while secondary stress is assigned postlexically (which then makes it impossible for secondary stress to be sensitive to lexical exceptionality). A further change was that rather than focusing on stress systems, van der Hulst broadened the approach to all *accentual systems* (thus including stress-accent, pitch-accent and tone accent systems, and, for that matter, every system in which words seem to have a privileged syllable or mora). For all such systems, the idea was that the privileged syllable is accented, with accent being devoid of intrinsic phonetic content.

Assigning primary accent first is not compatible with standard metrical accounts in which exhaustive footing comes first. In OT, van der Hulst's claim that primary accent comes first has in fact been taken as an argument to adopt a nonprocedural constraint-based approach which allows constraints bearing on head feet (primary 'stress') to outrank constraints bearing on dependent feet (non-primary 'stresses') or vice versa to deal with count systems.

In van der Hulst (1997, 1999, 2010, 2012, 2022, in prep.), I propose the same analysis for both unbounded and bounded systems, the difference being that the size of the accentual window comprises the whole word in unbounded systems and a smaller *foot-like* window in bounded systems, both subject to the option of an extra syllable *on either side* of the accentual domain, which are called satellites. Within the accentual windows, the accent location can be dependent on syllable weight. In addition, two parameters are needed, one for designating a 'winner' (*resolution*) when there is more than one accent in the window and one for the default location of the accent. It is shown that for bounded systems, no variant of metrical foot inventories is sufficient to account for the attested variety, which is why the bounded window is not a foot, but simply a domain within which the accent is located. Systems in which the location of primary accent/stress appears to be dependent on prior exhaustive footing (so-called count systems) present a problem for the primary accent first approach and various analyses of such systems have been entertained, the most promising of which attribute the primary 'stress' in such a system to intonational tones (see Gordon, 2014; van der Hulst, 1997).

Van der Hulst (2014) provides a theory of word rhythm which does not appeal to feet either but instead follows Prince (1983) in appealing to simple rules that assign rhythmic beats. For a different approach to word rhythm, see Hyde (2002, 2012).

Conclusions

This chapter focused on the metrical theory that proposed a parametric theory of word stress that was able to account for a broad variety of word stress types, both in terms of primary stress and in terms of non-primary stress. We considered several varieties of the original theory which differ with respect to including constituency in the representation of word stress patterns, as well as several different notational systems and different foot inventories. We discussed various proposals to modify the theory to arrive at a better match between the theoretical possibilities that the theory predicts and empirically attested languages. We briefly touched on the analysis of stress in OT. This article then proposed to subsume the notion *word stress* under the broader notion of *word accent*, allowing for the possibility of word accents being signaled by a variety of phonetic and phonological cues, including predominantly stress/intensity cues and pitch/tonal cues, giving rise to a distinction between stress-accent languages and pitch or tonal accent languages. We concluded with an outline of the so-called primary accent first approach which diverges from all versions of metrical theory making the assignment of rhythm dependent on the prior assignment of primary accent and rejecting the relevance of feet for both.

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