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METRICAL PHONOLOGY

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ABSTRACT

Metrical theory is a branch of phonology that posits a hierarchical structure to represent stress patterns in the minds of speakers. This review examines the basic arguments for this theory and surveys the central issues of the field over the past 18 years. These issues include questions about whether the foot typology is symmetric, whether there is a strict binarity requirement, and how to treat ternary iteration. The review concludes with a brief overview of the impact of constraint-based phonology on metrical theory.

INTRODUCTION

Metrical phonology is the branch of linguistic theory concerned with stress phenomena in natural language. It is distinguished from previous approaches in that it posits a hierarchical structure reminiscent of the structures used in traditional discussions of poetic meter,[1] hence the name metrical theory. It is also much broader in coverage in that it relates stress to several other domains.

Example 1 illustrates nominal stress in Lenakel (24, 25, 32, 68). Main stress falls on the penult. Secondary stresses fall on every other syllable to the left. In orthodox linear generative phonology (8) such a pattern would be described in terms of an *n*-nary stress feature. For example, word stress is formalized as in Example 2 and might be governed by the rules in Example 3.

[1] There are also analyses of poetic meter in terms of this theory of stress (see e.g. 33, 41, 45, 57).

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n-ám	N-fish	'fish'	1.
kɔ́lɛy		'sweet potato'	
kavέvaw		'hat'	
l-àgabnɨbən	in-morning	'in the morning'	
kayὲlawέlaw		'kind of. dance'	
lὲ-dubʊ̀lugál kʰ	in-lungs	'in the lungs'	

2.

kayὲlawέlaw
0 2 0 1 0

$$V \rightarrow [1stress] / \_\_ \; C_0 \, V \, C_0 \begin{Bmatrix} [1stress] \\ \# \end{Bmatrix} \quad \text{3a.}$$

$$V \rightarrow [1stress] / \_\_ \; C_0 \, V \, C_0 \, \# \quad \text{3b.}$$

The numbers indicate degrees of stress: "1" indicates primary stress and "0" indicates no stress. The rules apply to place primary stress. The first rule elevates all even-numbered syllables to primaries. The second rule elevates the final stress to a primary and—via the Stress Subordination Convention—demotes all other stresses by one. The Stress Subordination Convention requires that all stresses in a domain be demoted by one when a primary stress is assigned.

In metrical theory, such a pattern is described in terms of binary trochaic stress "feet." These feet are aligned with Lenakel forms in a right-to-left fashion and position stress on even-numbered syllables counting from the right edge of the word. Primary stress is placed with a superordinate structure. Both kinds of structures indicate stress in terms of "headedness." These constituency and headedness relationships can be diagrammed as follows:

```
                         x                          4.
         x               x
   x    (x    x)        (x    x)
k  a  y  ὲ   l a     w   έ   l a   w
```

How can these theories be distinguished and why should an anthropologist care? Briefly, the theories are distinguished in terms of the elaboration of the structure that indicates stress. Following standard generative thinking, both of these theories make claims about the way individuals represent stress patterns in the mind. The linear view would have it that each stressed syllable is independent from its neighbors and numerologically related to them. The metrical view holds that the syllables are grouped together in structures like the feet above. If these latter structures have any phonetic or phonological reality, then that would constitute evidence for the metrical theory.

Why should a nonlinguist—an anthropologist specifically—care about this theory? There are several reasons. First, in general, linguistic theories make claims about the limits of language learning, i.e. what is or is not learnable. To the extent that anthropologists are interested in what is cultural, as opposed to what is psychological, they should understand what is unlearnable, hence what is not subject to cultural control or variation. Second, this theory merits specific attention because it ties together domains of investigation that previously have been treated separately: stress or accent, poetic meter, reduplication, minimal word phenomena, and prosodic morphology. The theory makes claims about the covariation that can be exhibited in these different domains, and anyone interested in linguistic differences should understand the range of possible variation. Third, metrical theory is the domain of phonology in which optimality theory has developed the most. This new direction in linguistic theory has already achieved some extremely important results and has wide applicability both within and beyond traditional linguistic domains. A clear understanding of metrical phenomena provides an essential prerequisite to understanding optimality theory.

OVERVIEW OF LINGUISTICS AND PHONOLOGICAL THEORY

Let us briefly review some of the central assumptions relevant to metrical theory: generative linguistics, phonological theory, and phonetic theory.

What Is Generative Linguistics?

The basic assumptions of generative linguistics are perhaps familiar to most readers, but many of the central ideas of phonological theory become far less murky if these assumptions are laid out clearly. Many of these ideas are examined in some of Chomsky's more classic works (e.g. 7, 8).

First, the object of description is not language per se, but the unconscious knowledge responsible for an individual's intuitions of grammaticality (i.e. competence). The force of this assumption is that aspects of language may not be reflective of grammar and may be excluded from phonological description. Standard examples include speech errors, spoonerisms, and false starts, but this domain might also include phonetic implementation, processing limitations, etc.

Second, the focus or grail for generative linguists is Universal Grammar, or the innate endowment that, through acquisition or language development, makes the adult grammar possible. It has been most forcefully argued by

Chomsky that adult grammars are startlingly uniform given the great variability in linguistic experience. On the generative view, this uniformity follows from the common genetic endowment that enables people to learn language quickly and to come up with effectively the same grammars despite varying experience.

Third, grammatical descriptions should be explicit. This concept traditionally has been cast in terms of a computational description of generativity and a notional focus on rules. However, other perspectives are consistent with a general focus on explicitness (see below).

The standard evidence that we do need a grammar to account for linguistic behavior is linguistic creativity. Just as speakers of a language can produce sentences they have never heard before; they can judge the well-formedness of phonological patterns exhibited by novel or nonce forms.

What Is Phonology?

Generative phonology focuses on sound systems. The sound system of a language typically exhibits certain patterns. For example, the distribution of stresses in Lenakel is restricted, as shown above. The claim behind generative phonology is that although languages do not exhibit the same restrictions on their sound systems, the restrictions that do occur are bounded. For example, not all languages exhibit stress on every other syllable from the right. Languages exhibit iteration from different directions and at different intervals, e.g. left-to-right, right-to-left, edge-in, every other syllable, every third syllable (see below). However, some patterns are completely unattested, e.g. middle-out iteration or stress on every fourth syllable.

Following the generative orthodoxy, such limits are ascribed to Universal Grammar (8). The basic idea is that the child comes to the language task with certain predispositions about iterating stresses. These expectations reduce the learnable patterns to the observed (and predicted) cases.

In early generative theory, these expectations were encoded in a rule formalism. The idea was that the child was endowed with a template for phonological generalizations and used this template to come up with rules. As noted above, this was done by supposing a rule schema and a set of terms that could appear in that schema (8). The schema is given in Example 5 below, and the terms were the distinctive features.

$$A \rightarrow B \,/\, C \_\_ D \qquad 5.$$

In more recent generative phonology, the focus has shifted away from rules and toward representations. For example, in metrical theory, rather than restrict the rules that assign stresses, the set of possible feet is restricted. For example, one might propose that feet can only be binary and ternary, thus excluding as a possible language any system that exhibited stress on every fourth syllable. Recently, there has been a shift back away from representations.[2] Interestingly, the most recent shift away from representations has not been accompanied by a shift toward rules (see below).

Phonetics

Metrical phonology is largely a theory of prominence, but the phonetics of prominence are far from clear. Moreover, metrical phonology has been extended to account for a number of phenomena in which prominence per se does not appear to be at issue.

Consider first the question of prominence. Metrical theory can naively be understood as a theory of where the stresses can go. The basic idea—in generative terms—is that the child comes to the task of determining what generalizations govern the stress system of his or her language with expectations about what can be a stress system. These expectations limit the range of possible stress systems.

It is not clear what a child might listen for in trying to figure out what is or is not stressed. The principal cues for stress are assumed to be loudness, pitch, and length. Stressed syllables are typically louder, higher pitched, and longer (62). However, as Lehiste (62) argues, several systems defy this simple characterization. The most well-known case is English. Hayes (38) argues that the second syllables of words like *veto* and *motto* contrast in stress. This difference in stress is manifested only in the presence or absence of flapping or aspiration on the medial consonant, e.g. vít^{h}ò vs máɾo.

The task for the language learner is not to find stresses and then fit them to the limits imposed by metrical theory. Rather, the learner comes to the acquisition task with metrical theory and looks for virtually anything upon which to impose metrical structure. There would seem to be a clear bias for the usual cues of stress to be governed by metrical structure, but as the example from English shows, other properties can be governed by metrical structure as well.

WHAT IS METRICAL PHONOLOGY?

Although there are a number of competing versions of metrical theory, I provide here a fairly neutral version. As outlined above, the theory provides for a set of constituents that can be built over a string of syllables. The set of constituents and the algorithms available for assigning those constituents to strings comprise the guts of the theory.

2 This fascinating ebb and flow between rules and representations over the history of phonology is described in Anderson (2).

The central notion is the metrical foot. Most versions of metrical theory adopt at least two kinds of feet: iambs and trochees. An iambic foot dominates two syllables and places the stress on the second syllable. A trochaic foot also dominates two syllables and places the stress on the first one. Lenakel is an example of a trochaic language.

Aklan (Example 6) involves iambic feet (37). Stress falls on alternating syllables from the right edge of the word. If a heavy syllable (one ending in a consonant) is encountered in the scansion, it receives stress and the count is restarted. Which stress is primary is complex and not relevant here (see 37 for details).

nàg-k-in-à-lisúd	'worry-actor-past'	6.
k-in-à-putús	'wrap-instr focus-past-post'	
asírtàr	'lucky'	
hámbàg	'speak'	

Hayes argues that iambic systems almost exclusively depend on syllable weight. Trochaic systems are not limited in the same way. Systems like Lenakel do not depend on syllable weight, but other trochaic systems do.[3]

English is a familiar yet complex example (see 8, 22, 23, 31, 37, 50). Basically, the final syllable is skipped and trochaic feet are built right to left.

hát	táble	7.
ánimal	América	
ìnformátional	munìcipálity	
hàmamèlidánthemum		

That syllable weight plays a role in this system is shown by the "heavy penult rule": The rightmost stress of an English word cannot occur to the left of the penult if the penult is heavy (i.e. contains a long vowel or is closed by a coda consonant).

light penult	long penult	closed penult	8.
América	aróma	beránda	
cínema	balaláika	agénda	
aspáragus	hiátus	consénsus	
metrópolis	horízon	synópsis	
jávelin	thrombósis	amálgam	
vénison	coróna	uténsil	

3 One can argue that Lenakel does have a covert syllable weight system (see 26, 32).

Feet can be assigned to a string in at least two directions: left-to-right or right-to-left. Lenakel exhibits right-to-left footing. Maranungku exhibits left-to-right trochees (92).

tíralk	'saliva'	mérepèt	'beard'	9.
yángarmàta	'the Pleiades'	lángkaràtetì	'prawn'	
wélepènemànta	'kind of duck'			

Iambic systems can also exhibit different directionalities. Aklan above is right-to-left; Munsee is left-to-right (16). Some languages exhibit several different directions (see 25, 64). Such "bidirectional" systems typically build a foot at one edge of the domain and then iterate toward that edge from the other.

Assigning feet to words or phrases will capture a system that distinguishes between stressed and stressless syllables. However, some systems exhibit several degrees of stress. For example, Lenakel has two degrees of stress: main and secondary. To capture such systems, higher-order structures are built over feet. Following Prince (80), this can be described in terms of the "End Rule." This rule selects out a peripheral foot for main stress; all other feet have secondary stress. In Lenakel, the rightmost foot is promoted by the "End Rule Right."

We can represent the structures discussed so far using the typographically convenient constituentized grid, an example of which was given in Example 4 above and is repeated below as Example 10.[4]

```
                       x               line 2      10.
           x           x               line 1
       x  (x    x )   (x    x )        line 0
     k  a  y  ɛ̀  l  a   w  ɛ́  l  a  w
```

Syllabic constituency is indicated on line 0. Syllables with any degree of stress are marked on line 1, and the result of the End Rule is marked on line 2.

Additional evidence for unstructured nonbinary stress is that the End Rule also appears to apply to unfooted spans directly. In some languages the first, last, first heavy, or last heavy syllable is promoted to prominence with no evidence for binarity. Czech (with initial stress) or French (with final stress) provide familiar and simple examples of such systems. Khalkha Mongolian (Example 11) provides an example of a system in which quantity matters (90). In Khalkha, the leftmost long vowel is stressed. If there is no long vowel, the first syllable is stressed.

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[4] According to Hammond (23, 27, 33), the constituentized grid is really a notational variant of the (albeit less typographically convenient) arboreal grid.

bosgúul	'fugitive'	11.
bariáad	'after holding'	
áli	'which'	
xoyərdugáar	'second'	
xốtəlbərə	'leadership'	
garáasaa	'from one's own hand'	

The precise analysis of such systems is controversial, but clearly there is no evidence for metrical constituency in such systems, binary or otherwise (see 22, 26, 37 for different approaches).

Finally, there is evidence for an intermediate level of prominence and constituency between feet and main stress: the superfoot or colon. Hungarian provides the clearest example (28). In Hungarian, main stress falls on the first syllable of the word. Subsidiary stresses fall on alternating syllables counting rightward. These subsidiary stresses are ranked in an alternating pattern: For example, the third, seventh, and eleventh syllables have less stress than the fifth, ninth, and thirteenth. Representative data are given in Example 12. Primary stress is marked with an acute accent, secondary stress is marked with a circumflex, and tertiary is marked with a grave.

ví:z	'water'	12.
kɔ́pɔ	'hoe'	
kɔ́pa:vɔ̀l	'with hoe'	
tɛ́ri:tø̀:vɛl	'with tablecloth'	
fé:lɛmɛ̀lɛtɛ̂n	'on mezzanine'	
fé:lɛmɛ̀lɛtɛ̂id	'your mezzanines'	
kíšku:nfè:lɛɟhâ:za:bɔ̀n	'in Kiskúnfélegyháza'	
mɛ́gvɛstegɛthɛ̂tɛtlɛ̀nɛk	'unbribable (ones)'	
mégvɛstɛ̀gɛthɛ̂tɛtlɛ̀nɛknɛ̂k	'to those unbribable'	
ɛ́lka:pòsta:šî:tottɔ̀lɔnîi:tott	'decabbagized (!)'	
lɛ́gmɛgvɛ̀stɛgɛ̂thɛtɛ̀tlɛnɛ̂bbɛknɛ̀k	'to those least bribable'	
ɛ́lka:pòsta:šî:tottɔ̀lɔnî:tottà:tok	'you've decabbagized it'	

This pattern can be analyzed as follows: Trochees are built from left to right on syllables. Trochees are then built again on the roots of the original trochees. End Rule Left promotes the first foot of the second round of trochees. A sample derivation is given in Example 13.

```
                                                     x                       13.
                                                     x           x
                       x      x       x      (x        x)  ( x )
 x  x  x  x  x       (x x)  (x x)  ( x )     (x x)  (x x)  ( x )
 fé: l ɛm ɛ̀ l ɛ t ɛ̂ n → fé: lɛ  m ɛ̀ lɛ  t ɛ̂ n → fé: lɛ  m ɛ̀ lɛ  t ɛ̂ n
```

Passamaquoddy has also been cited as an example of cola or superfeet (89).

Finally, the mechanism of extrametricality allows a syllable at the edge of the footed span to be skipped. In the earliest work on metrical theory, this skipping option was thought to be limited to edges. English (see above) is an example of this pattern; Western Aranda is another particularly striking example (11, 91). Stress in Aranda falls on odd-numbered syllables counting from the left, with two exceptions. Word-final syllables never receive stress and a vowel-initial word receives stress on even-numbered syllables. Davis (11) cites the following data (pp. 399–400):

túkura	'ulcer'	14.
kútungùla	'ceremonial assistant'	
wóratàra	(a place name)	
ergúma	'to seize'	
artjánama	'to run'	
utnádawàra	(a place name)	
káma	'to cut'	
ílba	'ear'	
wúma	'to hear'	

These data receive the following analysis here:

(*a*) Make the final syllable extrametrical; 15.
(*b*) make a word-initial vowel extrametrical;
(*c*) build trochees from left to right.

This analysis assumes that the entire span cannot be made extrametrical. This principle is most well known as exhaustivity (36, 37, 39) and is needed to account for the difference between forms like *ílba* and *ergúma*. The former bears initial stress because initial extrametricality is blocked because it would violate the exhaustivity principle. The latter bears second syllable stress because initial extrametricality succeeds because exhaustivity is not invoked. Sample derivations are given in Example 16. Extrametricality is marked with angled brackets.

16a.
```
                                        x
x       x       x    <x>               (x)   <x>
i l b a  →  i l b a  →  n / a  →  i l b a
```

16b.
```
                                                                  x
x      x    x      x      x   <x>   <x>     x  <x>   <x>     (x)     <x>
e r g u m a  →  e r g u m a  →  e r g u m a  →  e r g u     m a
```

In summary, metrical theory provides for a set of constituent types (feet, and cola or superfeet) and a set of algorithms for assigning those constituents to strings. That set of constituents is supplemented with the End Rule and extrametricality. The test for this theory is whether the constituency claimed has any empirical consequences. If so, this would constitute a dramatic argument in favor of metrical theory over any linear alternative (e.g. 8).

EVOLUTION OF THE FIELD

This section traces the history of metrical theory since 1968, starting with the earliest challenges to linear phonology and concluding with an introduction to optimality theory.

Linear to Nonlinear

Chomsky & Halle (8; see above) conceived of stress as no different in kind from other features, e.g. [nasal], [coronal], [strident]. This theory had the desirable property of uniformity; the substantive differences between speech sounds were formalized in terms of the same sorts of formal objects.

This theorized uniformity, however, leads to some problems (see 66, 85). For example, stress is not like other phonetic variables. Properties such as nasality are absolute in that a lowered velum is equated with [+nasal] regardless of context. Stress, on the other hand, is relative in that the stress of a syllable is determined in comparison with other syllables. This relativity was expressed in two ways in Chomsky & Halle's theory. First, there are different degrees of stress and these needed to be encoded numerically, e.g. [1stress], [2stress], etc. This is in stark contrast to all other features, which were treated as binary in the phonology.[5] Second, this also led to the Stress Subordination Convention (see Example 3), which allowed local changes to a single segment to affect all other segments in the string undergoing the relevant rule. No other features required a similar convention.

There were also empirical problems with Chomsky & Halle's analysis. Liberman & Prince (66) show that the interaction of Chomsky & Halle's Compound Stress Rule (CSR) and Nuclear Stress Rule (NSR) produce incorrect forms. Basically, the NSR stresses the last word in a phrase, whereas the CSR stresses the penultimate word in a compound.

compounds:	bóttle brùsh	1 2	17.
phrases:	Jòhn rúns	2 1	

[5] Chomsky & Halle did maintain that all binary phonological features were to be translated into integer values in the phonetics, but according to their theory, the only integer values to which the phonology needed to refer were those associated with the feature [stress].

In more complex phrases, both rules apply cyclically and invoke the Stress Subordination Convention. Cyclic application means that the rule applies to innermost constituents and then reapplies at each successively larger domain, invoking the Subordination Convention each time. Thus a compound like *bottle brush handle* undergoes a three-step derivation as follows. First, stress is assigned to each word independently. Then compound stress is assigned to the embedded compound *bottle brush*, assigning primary stress to the penultimate primary, invoking the Stress Subordination Convention and reducing the stress on *brush* from primary to secondary. Finally, compound stress is reapplied to the whole compound, assigning primary stress to the penultimate primary *bottle*—skipping *brush*—and demoting *brush* and *handle* again.

b o t t l e	b r u s h	h a n d l e		18.
1	1	1	step 1	
1	2		step 2	
1	3	2	step 3	

Notice how cyclic application produces a rising profile among the demoted stresses to the right of the main stress. Notice too how cyclic application demotes *brush* on the inner cycle before the compound stress rule has a chance to apply to the whole compound, preventing the ungrammatical **bòttle brúsh hàndle*.

Phrasal stress is assigned in a similar fashion. Example 19 contains a three-part cyclic derivation. First, each word is assigned primary stress. Next, phrasal stress is assigned to the embedded phrase *sees Mary*, promoting the final primary and demoting *sees*. Finally, phrasal stress is reassigned to the entire phrase, demoting *John* and *sees*.

J o h n	s e e s	M a r y	19.
1	1	1	
	2	1	
2	3	1	

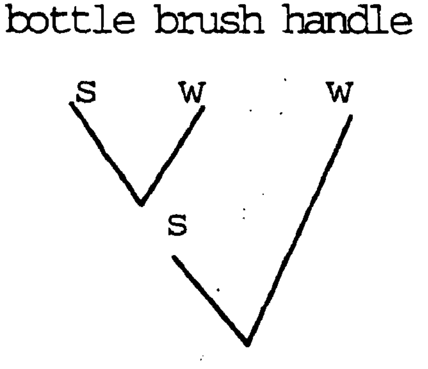
Liberman & Prince (66) point out that although the Chomsky & Halle algorithm works fine with compounds embedded in phrases, it does not work when applied to phrases embedded in compounds. Example 20 shows how the algorithm succeeds with a compound embedded in a phrase.

J o h n	s e e s	b o t t l e	b r u s h e s		20.
1	1	1	1		
		1	2	CSR	
	2	1	3	NSR	
2	3	1	4	NSR	

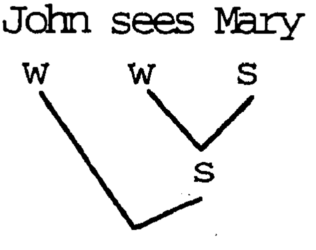
Consider how the rules would apply to a compound *motor unit neural control*, containing the phrase *neural control*. First, each word is assigned primary stress. Then the CSR applies to *motor unit* and the NSR applies to *neural control*. Finally, the CSR applies to the whole thing. Notice that because the CSR seeks out the penultimate primary stress, it incorrectly promotes *motor*, rather than *control*. (The attested pronunciation has the strongest stress on *control*.)

m o t o r	u n i t	n e u r a l	c o n t r o l	21.
1	1	1	1	
1	2	2	1	
*1	3	3	2	

The problem is that the Chomsky & Halle rules are sensitive only to the numerical values for the feature [stress]. Liberman & Prince (66) propose an algorithm based on the overt branching structure. In their algorithm, all constituency is indicated with binary branching. All branches are labeled either strong or weak, where strength is the formalization of stress. In a phrase, the right branch is always strong. In a compound, the right branch is strong if and only if it branches. The examples above are thus realized as follows:

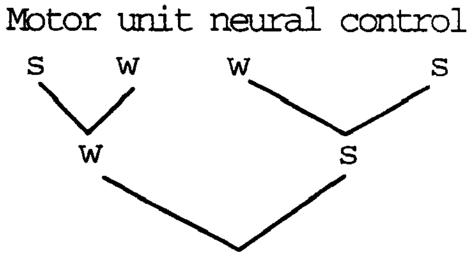


22.



23.

24.



Liberman & Prince's algorithm accounts for the problem with phrases embedded in compounds, but it provides for several other desiderata as well. First, it provides an expression of the insight that stress is relative rather than absolute. Second, it extends naturally to account for word-internal stress patterns (66). Third, it has no need for the cycle.[6] Fourth, it accounts readily for other kinds of stress systems (21, 37, 70). This last result is extremely important. Chomsky & Halle's analysis (8) was of English. Hyman (47) did the first real typological generative work on stress. He argued that a number of generalizations restrict the stress systems of the world. These patterns are not, however, easily captured within Chomsky & Halle's paradigm. This kind of typological work was a central impetus for the development of a parametric metrical theory.

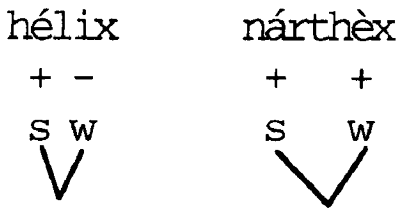
Several of the arguments above have since been shown to be too strong. For example, the elimination of the cycle was not possible. This was first shown by Kiparsky (58; see also 20, 31). Also, conditions on branching have been shown to be unnecessary (44, 80).

Grids and Trees

Liberman & Prince's theory (66) has three components: a binary stress feature [±stress], the metrical tree, and the metrical grid. Whether all three representations are necessary and, if not, what kind of hybrid representations should be adopted in their stead was a hotly debated topic.

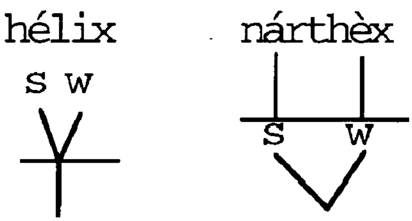
We have already seen empirical and theoretical motivation for the metrical tree in the treatment of compound stress in English. The need for a binary stress feature can be seen readily by comparing English words such as *hélix* and *nárthèx*. Under the metrical theory outlined above, these words would have the same binary metrical tree labeled 's w.' However, the latter differs from the former by having a final secondary stress. Some additional structure was needed to encode this difference and Liberman & Prince (66) posited a binary stress feature. The two representations are given below in Example 25.

6 Rischel (84) made a similar argument with respect to Danish compounding.



25.

There are other ways to capture this distinction as well. Hayes (37) proposes to do away with the binary stress feature by adopting levels in the metrical tree, i.e. the foot. In Hayes's notation, stress must be strong in a foot. This is exemplified in Example 26 below, where the horizontal line separates the foot level.



26.

Liberman & Prince also use a second representation: the metrical grid. They motivate this in their discussion of the rhythm rule in English.[7] The rhythm rule is responsible for the leftward shift of stress in a modifier when it is followed too closely by a stress in the next word (Example 27) (see also 23, 42, 65 for discussions of rhythm in English).

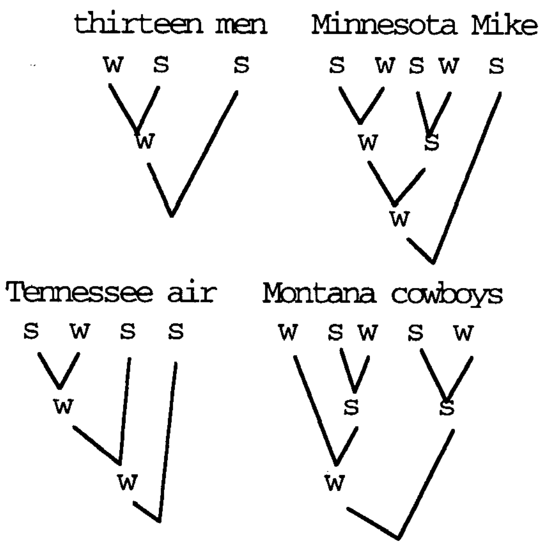
thìrtéen	thìrtéen mén → thírtèen mén	27.
Mìnnesóta	Mìnnesóta Míke → Mínnesòta Míke	
Tènnessée	Tènnessée áir → Ténnessèe áir	
Mòntána	Mòntána cówbòy → *Móntàna cówbòy	

It is rather difficult to account for the possible shifts if only a tree representation is used. Liberman & Prince propose to augment the metrical tree with a metrical grid. The grid is constructed by aligning columns of marks or ticks with syllables, such that degree of stress is encoded in terms of the height of the columns. Example 28 shows the tree representations for the phrases in Example 27, and Example 29 shows the grid representations.

7 Similar rhythmic processes apply in other languages, e.g. Italian (77), Tiberian Hebrew (79), Tunica (23).

Liberman & Prince argue that the rhythm rule applies when there is a clash in the metrical grid. A clash is defined as adjacent marks at two contiguous levels of the grid. (Clashes are marked with hyphens below.)

28.



29.

```
                    x
          x - - - - x
    x     x         x
t h i r t e e n   m e n

                      x
            x - - - - x
x           x         x
x       x   x   x     x
M i n n e s o t a   M i k e

                    x
              x - - x
  x           x - - x
  x     x     x     x
T e n n e s s e e   a i r

                  x
        x         x
  x     x   x     x     x
M o n t a n a   c o w b o y s
```

The obvious question is why two separate representations should be necessary. This question is explored in both directions. Prince (80) explores the possibility that there is only the grid (see also 87). He proposes that there is no constituent foot and that stress in languages like Lenakel would be assigned by aligning words with the perfect grid.

30.

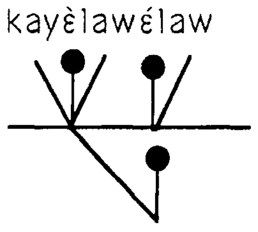
```
        x   x   x   x
. . . x x x x x x x x . . .
```

The perfect grid is composed of peaks and troughs. The higher columns are peaks; the lower columns are troughs. In Lenakel, the perfect grid is aligned with strings from the right to left trough first.

```
              x                 31.
        x     x
     x  x  x  x  x
    k a y ɛ̀ l a w ɛ́ l a w
```

Hammond (23) proposes a different solution, in which grids are constituentized: the arboreal grid. The resulting representation indicates clashes and foot structure.

32.



If constituency cannot be manipulated independently of metrical headship, then this formalism is notational with a grid with constituency added on: the constituentized grid. This latter formalism is proposed by Halle & Vergnaud (22) and is adopted here for typographical convenience.[8]

```
                 x              33.
        x        x
    x  (x   x )  (x   x )
   k a y ɛ̀ l a   w ɛ́ l a w
```

There is extensive evidence for metrical constituency (see below). This evidence constitutes support for a constituentized representation (arboreal grid or constituentized grid) and support for metrical theory in general.

Morphology

A rather dramatic development took place after the debate over representations above. McCarthy & Prince (72) argued that a broad class of morphological operations are sensitive to metrical structures (see e.g. 63, 73 for refinements of this theory).

Earlier work took a different perspective. Moravcsik (76) had provided a broad typological overview of reduplication, and Marantz (69) extended McCarthy's (70) CV-skeleton theory to account for these facts. The CV-skeleton theory maintained that phonological representations were organized

8 See Hammond (27, 30) for a discussion of the potential independence of constituency and headship (see also 10, 17).

around timing units specified only for whether they were consonants (Cs) or vowels (Vs). Consider reduplication in Tagalog (4).

ipon	i-ipon	'just saved'	34.
bloaut	bo-bloaut	'just gave a special treat'	
trabaho	ta-trabaho	'just finished working'	
galit	ga-galit	'just got mad'	

Marantz would characterize this pattern of reduplication as involving a skeletal prefix of the form CV, which obtains its segmental content from a copy of the base segments. Although this theory offers a concise formal description of a wide variety of reduplication types, it fails to limit them in a satisfactory way. The theory predicts that any combination of basic Cs and Vs should constitute a possible reduplicative affix, but this is not the case.

Rather, McCarthy and Prince argue, the set of possible reduplicative affixes is defined by the set of prosodic categories. These categories include various sorts of feet and syllables. Moreover, they argue, these prosodic categories define not just the set of reduplicative affixes, but the set of templates and loci in which morphological operations can occur.[9] Yidin^{y} provides an example of foot-based reduplication (12, 13, 38) .

gindalba	gindalgindalba	'k.o. lizard'	35.
mulari	mulamulari	'initiated man'	
kalamparaa	kalakalamparaa	'march fly'	

The existence of morphological operations defined in terms of disyllabic units obviously provides support for the theory of stress that groups syllables together.

Other sorts of morphological operations also converge on this result. Consider infixation in Chamorro (9): Main stress falls on alternating syllables counting from the right edge of the word.

magágu	'clothes'	màgagú-ña	'his clothes'	36.
kadúku	'crazy'	màn-kadúku	'crazy'(pl)	

Ignoring irrelevant complications, stress can be assigned by building trochaic feet from right to left. The continuative is formed by reduplicating the first syllable of the rightmost foot.

9 Some of this work builds on an earlier paper by Broselow & McCarthy (5).

[sága]	sa[sága]	'stay'	37.
[égga]	e[ʔégga]	'watch'	
hu[gándo]	huga[gándo]	'play'	

Finally, there are normal affixation operations that simply fail if the base of affixation does not meet some prosodic type. English comparative formation is limited in this way. The suffix *-er* can only be added to monosyllables or trochees, e.g. *bígger, háppier*, but **alérter, *cómicaler.*

Treatment of the two domains continues today (for other evidence of metrical constituency, see e.g. 1, 18, 22, 29, 40, 71, 81).

Symmetry

Halle & Vergnaud (21), McCarthy (70), and Hayes (37) have proposed symmetric and parametric metrical theories (see also 22, 49). These theories were parametric because the set of occurring metrical feet was a function of setting a finite set of parameters; they were symmetric because the parameters could combine freely, producing the combinatorial maximum for the interacting parameters.

Consider, for example, headedness and quantity sensitivity. Assuming only binary feet, headedness allows for either left-headed or right-headed feet. Quantity sensitivity dictates whether nonheads of feet can dominate heavy syllables. (Quantity sensitivity allows heavy syllables to attract stress.) These two binary parameters can cross to produce the combinatory maximum of four foot types.

Headedness	Quantity-sensitivity	foot	
left	quantity-sensitive	√	38.
left	quantity-insensitive	√	
right	quantity-sensitive	√	
right	quantity-insensitive	√	

Hayes (43) argues that this perfect symmetry does not hold. The argument is made on the basis of a dramatic typological investigation and can be summarized in the following chart.[10]

[10] These results are anticipated in the overview given at the beginning of this review (see also 44, 46, 72).

Headedness	Quantity-sensitivity	Attested foot
left	quantity-sensitive	?
left	quantity-insensitive	√
right	quantity-sensitive	√
right	quantity-insensitive	*

39.

According to the above chart, there is no evidence for a right-headed quantity-insensitive foot. All right-headed feet appear to be quantity-sensitive. Furthermore, the left-headed quantity-sensitive foot is affirmed but not the one predicted by the symmetric theory. The symmetric theory maintained that a left-headed quantity-sensitive foot was simply restricted in whether the nonhead could dominate a heavy syllable. Hayes maintains instead that the left-headed quantity sensitive foot could dominate either one heavy syllable or two light ones. If such a span is unavailable, no foot is built.[11]

Evidence for this new left-headed foot—the moraic trochee—comes from Palestinian Arabic (53, 54). Hayes cites the following examples:

makáatib	offices	40.
mooládna	our feast	
ḍárabato	she hit him	
bákara	cow	
šaǰarátuhu	his tree	
baarákato	she blessed him	
báarako	he blessed him	

The analysis proceeds as follows: Moraic trochees are built from left to right. The final foot is made extrametrical, and End Rule Right applies. Some sample derivations are given in Example 41 below. Notice that if the rightmost foot is not word-final, extrametricality is vacuous.

41.

```
                                                  x
                         x                        x
  x   x x   x          x (x x)  x           x   (x x)  x
m a k á a t i b      m a k á a t i b      m a k á a t i b

                                                         x
                      x      x                 x         x
  x x   x x   x      (x x)  (x x)  x         (x x)     (x x)  x
m o o l á d n a     m o o   l á d n a       m o o      l á d n a
```

[11] Hayes (44) claims that a headless foot is built, but subsequent researchers have assumed no foot is constructed in such circumstances.

```
                                               x
                      x         x              x         < x >
 x   x   x   x       (x   x)   (x   x)        (x   x)   (x   x)
ḍ á r a b a t o      ḍ á r a   b a t o        ḍ á r a   b a t o

                                    x
                  x                 x
 x   x   x       (x   x)  x        (x   x)  x
b á k a r a      b á k a r a       b á k a r a

                                                          x
                      x        x              x           x
 x   x   x   x   x   (x   x)  (x   x)  x     (x   x)    (x   x)  x
š a ǰ a r á t u h u  š a ǰ a  r á t u h u    š a ǰ a    r á t u h u

                                                      x
                    x      x                  x       x
 x x   x   x   x   (x x)  (x   x)  x        (x x)   (x   x)  x
b a a r á k a y o  b a a  r á k a t o      b a a   r á k a t o

                                       x
                x      x               x    < x >
 x x   x   x   (x x)  (x   x)        (x x)  (x   x)
b á a r a k o  b á a  r a k o        b á a  r a k o
```

Left-headed quantity-sensitive feet fail to account for this pattern. Following are the same examples footed with traditional parametric left-headed quantity-sensitive feet. Asterisks mark forms that would receive incorrect stress under this analysis.

```
                                             x                42.
                           x                 x
 x   x x   x           x  (x x   x)       x  (x x   x)
m a k á a t i b      m a k á a t i b     m a k á a t i b

                                              x
                     x       x                x    < x >
 x x   x x   x      (x x)   (x x   x)       (x x)   (x x   x)
m o o l á d n a     m o o   l á d n a      *m o o   l á d n a

                                             x
                    x        x               x       < x >
 x   x   x   x     (x   x)  (x   x)         (x   x)  (x   x)
ḍ á r a b a t o    ḍ á r a  b a t o         ḍ á r a  b a t o
```

```
                                      x
                     x                x
  x    x    x      (x    x)  x      (x    x)  x
b  á  k  a  r  a   b  á  k  a  r  a   b  á  k  a  r  a

                                                       x
                           x        x                  x        x
  x   x   x   x   x      (x   x)  (x   x)  x        (x   x)  (x   x)  x
š a ǰ a r á t u h u      š a ǰ a   r á t u h u      š a ǰ a   r á t u h u

                                                    x
                         x           x              x         < x >
  x x   x   x   x      (x x)       (x   x)       (x x   x)    (x   x)
b a a r á k a t o     b a a r á   k a t o      *b a a r á    k a t o

                                                x
                        x      x                x     < x >
  x x   x   x         (x x)  (x   x)          (x x)  (x   x)
b á a r a k o        b á a   r a k o         b á a   r a k o
```

The theory that emerges from this approach is no longer parametric in the same sense. Under the symmetric theory, parameters combine to define a set of basic feet. Under Hayes's theory, the basic feet are primitive and are only parametric in that they come from a finite list.

Binarity and Catalexis

One of the issues that comes out of Hayes's asymmetric typology is the absence of a monosyllabic default foot. As exemplified in the above analysis of Palestinian, if the span is insufficient, no foot is built. In the case of a moraic trochee, if there is less than either a heavy syllable or two light syllables, no foot is built. Previously, such feet were countenanced by the theory and were termed degenerate feet. Whether such feet should be allowed has been hotly debated.

Some languages appear to allow for superficial degenerate feet. In Maranungku (see Example 9), syllabic trochees are built from left to right. Notice though that a final degenerate foot is built in words with an odd number of syllables. This is an apparent counterexample to the asymmetric foot typology. Hayes suggests the final stress in such cases is only apparent, that it is only some kind of word-final lengthening.

An alternative explanation is proposed by Kiparsky (59), who suggests the mechanism of catalexis as a way of accounting for the following generalization: Languages with trochaic feet that permit final stress typically do not have a minimal word constraint. This generalization can be seen by comparing Ono and Diyari. Ono has final stress and no word minimum (78).

kúm	'palm bark'	43.
déne	'my eye'	
árilè	árilè	

Diyari, on the other hand, has no final stresses and a bisyllabic word minimum (3).

kána	'man'	44.
pínadu	'old man'	
wílapìna	'old woman'	

The basic idea behind catalexis is that some languages allow for an invisible (or catalectic) syllable at the edge of a word. Coupled with a strict binarity requirement on feet, the option of catalexis will derive the two possibilities above. Ono allows for a catalectic syllable (marked with square brackets below); Diyari does not.

```
 x              x          x        x                     45.
(x      x)     (x    x)   (x   x)  (x    x)
k ú m  [σ]     d é n e     á r i    l è  [σ]
```

```
          x          x              x        x            46.
 x       (x   x)    (x    x)  x    (x   x)  (x   x)
*σ       k á n a    p í n a d u    w í l à   p ì n a
```

The catalectic syllable allows for subminimal words (monosyllables) and final stress. The prediction is that there will be no (trochaic) language that has final stress and a bisyllabic minimal word, and no language that allows monosyllabic words but not final stress. Kager (51) tested these predictions extensively.

There are other uses for catalexis as well. For example, Kiparsky argues that the otherwise mysterious stress system of Tübatulabal (see 93) receives a natural treatment if there is final catalexis. Tübatulabal has rigid final stress accompanied by stresses on every other mora to the left. The final stress requirement suggests the feet are iambs, but the "every other mora" requirement suggests the feet are moraic trochees.

táaháwilá	'the summer' (obj.)	47.
haníilá	'the house' (obj.)	
éeyéeú	'he became ashamed'	
witáyhatál	'the Tejon indians'	
wítayhátaláabacú	'away from the Tejon indians'	

Kiparsky solves this conundrum by proposing that there is a final catalectic syllable with moraic trochees built from right to left.

48.

```
 x      x       x            x      x       x      x    x
(x x)  (x  x)  (x  x)    x (x x)  (x  x)  (x x)  (x x) (x  x)
t á a  h áw i  l á [s]   h a n í i  l á [σ]   é e  y é e  ú [σ]

     x      x              x       x       x       x
 x  (x  x) (x      x)     (x  x)  (x  x)  (x x) x (x  x)
 w i t á y h a  t á l [σ]   w í t a y h á t a  l á a b a c ú [σ]
```

Though most linguists are naturally suspicious of such invisible elements, the mechanism of catalexis brings together a number of generalizations.

Ternarity

A lot of recent research has focused on accounting for apparent ternary iteration. Consider stress in Cayuvava. Cayuvava was first brought to the attention of the metrical world by Levin (63) (see also 34, 46, 83, 88). The data below are from Key (55, 56). Stress in Cayuvava falls on every third vowel counting from the right end of the word (63, pp. 101–102).

49.

(*a*)	dáru	'hand'
	éne	'leaf'
(*b*)	sákahe	'stomach'
	ríbera	'leg'
(*c*)	kihíBere	'I ran'
	takáasi	'old man'
(*d*)	arikájahi	'he has already fallen'
	Bariékimi	'seed of squash'
(*e*)	pópohecéBaka	'inside of cow'
	Bádacaóai	'my younger brother'
(*f*)	aBárericákaA	'palate (Px)'
	maráhahaéiki	'their blankets'
(*g*)	ikitáparerépeha	'the water is clean'
	tiBiBíoaíine	'she spanks me again'
(*h*)	cáadiróboBurúruce (caadáirobóirohíine)	'ninety-nine'
	(Bururuce) medárucecéirohíine	'fifteen each'

The most straightforward account would be to admit a new foot type, the dactyl, which would have three terminals with the head on the left. At least four other approaches have also been taken.

Halle & Vergnaud (22) propose augmenting the set of possible feet to allow for anapests: ternary feet with the head in the middle. Coupled with final extrametricality, such feet can account for the patterns above. Hammond (34) argues that these patterns can be captured with binary feet if the theory of extrametricality is expanded to admit, as a marked case, extrametricality in the middle of words. Hayes (46) argues that there are at least two ways a span can be parsed into feet. Under strong local parsing, binary feet are built next to each other; under weak local parsing, binary feet are built one light syllable away from each other.

The binary approaches have two advantages over the approaches admitting primitive ternary feet: First, binary approaches maintain a restrictive foot typology. Second, they account for the emergence of binarity even in ternary systems. (For example, the minimum word in Cayuvava is two syllables, not three.) On the other hand, both binary approaches expand the theory in other respects. The relativized extrametricality proposal must admit nonperipheral extrametricality. The weak local parsing approach must allow for a new footing algorithm. How best to account for ternarity is an open question.[12]

Optimality Theory

A recent development in metrical theory (and in other areas of phonology as well) is optimality theory (OT) (e.g. 74, 82). This theory represents a major step forward in many respects, although in some ways, it is a return to ideas that were developed a number of years ago.[13] In some respects, it is a rejection of some of the central ideas that have dominated nonlinear phonology for the past twenty years.

The basic idea behind OT is that ordered phonological rules are rejected in favor of ranked and violable constraints. For example, the stress patterns of Lenakel above could be described by imposing the following constraints.[14]

PARSE: Syllables must be footed. 50.

FTBIN: Feet must be binary. 51.

ALIGN: Feet must be aligned with the left/right edge. 52.

TROCHEE: Feet are trochaic. 53.

---

12 Kager (52) and Fitzgerald (14) both treat ternarity in an optimality theory framework.

13 Constraints have been around in phonology for a long time (see e.g. 61). See Hammond (23) for an early constraint-based approach to rhythm and Selkirk (86) for a constraint-based approach to lexical stress.

14 All of these constraints are attested in the OT literature. I give them here in a somewhat more informal form for expository ease.

The constraints FTBIN and TROCHEE are unviolated and, in the terminology of OT, undominated in the constraint hierarchy. The constraints ALIGN and PARSE are both violable in order to minimize violations of the superordinate FTBIN. Furthermore, ALIGN is violable to satisfy PARSE. These ranking relationships can be captured with the following hierarchy.

{FTBIN, TROCHEE} >> PARSE >> ALIGN   54.

These constraints and ranking relationships can be exemplified in the following constraint tableau. Ranking of constraints is indicated by left-to-right ordering (and solid as opposed to dotted lines). Under OT, a set of candidate forms is generated by the function GEN. The constraint hierarchy then applies, and violations of the various constraints are assessed. The guiding principle here is "strict ranking": A violation of a higher constraint is damning if there is an alternative candidate that does not induce the same violation. (Such damning violations are marked with an exclamation point and rightward shading.)

55.

/kayɛlawɛlaw/	FTBIN	TROCHEE	PARSE	ALIGN
kayɛlawɛlaw			******!	
(káyɛ) (láwɛ) law			*	****!
(káy)la(wɛ́law)			*	***!
☞ ka(yɛ́la) (wɛ́law)			*	* *
ka(yɛlá) (wɛláw)		*!	*	* *
(ká) (yɛ́la) (wɛ́law)	*!			******
kayɛla(wɛ́law)			***!	

Notice that none of the candidates escapes violating at least one constraint. Multiple violations are reckoned in the relevant cases and indicated by the number of asterisks.

This approach has several advantages over a rule-based approach. One of McCarthy & Prince's strongest arguments comes from infixation in Tagalog (15). In Tagalog, the progressive infix *-um-* is positioned before the first vowel of a word.

sulat	'write'	sumulat	56.
aral	'teach'	umaral	
gradwet	'graduate'	grumadwet	

This observation is an embarrassment to the theory of prosodic morphology developed by McCarthy & Prince (72) because, as noted above, the locus of infixation was thought to coincide with the edges of prosodic constituents, e.g. feet and syllables. (A vowel is not a member of this set.)

McCarthy & Prince (74) argue that the facts of Tagalog can be accounted for by proposing that the position of the infix is governed by prosodic factors but not simply crude alignment of the affix with the edge of some prosodic category. Specifically, they propose that the affix goes as far to the left as it can, subject to the constraint that coda consonants are avoided.

Thus a form like *aral* undergoes infixation as *umaral*, rather than as **aumral* because the latter contains a coda. The form **arumal* is also not the output because there is an alternative form still not containing an additional coda in which the *-um-* occurs further to the left: *umaral.* Contrast this with *grumadwet*, in which positioning the infix further to the left always results in an extra coda: **gumradwet* or **umgradwet.*

This relationship can be modeled easily in OT terms, in which a constraint on position is subordinate to a constraint against codas. These relationships are diagrammed in the following tableaux.

{um+aral}	NoCoda	Leftmost
☞ umaral	*	
aumral	**!	*
arumal	*	**!

57.

{um+gradwet}	NoCoda	Leftmost
umgradwet	***!	
gumradwet	***!	*
☞ grumadwet	* *	* *
graumdwet	***!	***

58.

The difference between stress in Tongan and English provides a nice metrical example. Both languages exhibit right-to-left footing with moraic trochees. However, they differ in their treatment of a long vowel in penult position. In English, such a vowel receives stress, presumably exhibiting the following structure (if strict binarity is assumed).

```
    x
x  (x x)  x
a r ó : m a
```

59.

In Tongan, such spans are reanalyzed so that the penult is realized as a string of two light syllables. Compare the following forms.

```
  x                        x
 (x x)                   x (x   x)
h ú :   'go in'        h u. ú  f i   'open officially'
```

60.

This splitting up of the penult allows the word-final foot to occur at the edge of the word and still only dominate two light syllables.

Under a derivational view, the Tongan facts would require two passes of syllabification. The first pass would produce syllables to which the stress rules would apply. The second pass would readjust that syllable structure to accommodate the metrical requirements. The problem is that there is no evidence for two separate syllabification stages.

This difference between the two languages is readily accounted for in terms of constraint ranking. Prince & Smolensky posit two constraints: RIGHTMOST and ONSET. RIGHTMOST wants the foot to occur as far to the right as possible. ONSET wants VV sequences to syllabify as long vowels. The difference between English and Tongan comes from differential ranking of these constraints. This is exemplified in the following tableaux.

/huufi/	RIGHTMOST	ONSET
[húu]fi	*!	
☞ hu[úfi]		*

61.

/arooma/	ONSET	RIGHTMOST
☞ a[róo]ma		*
aro[óma]	*!	

62.

Similar arguments are presented in Prince (81) and Mester (75).

Most of the work in generative phonology that has been presented at the major conferences over the past two years has been in terms of OT (but see 19, 49 for arguments against a purely constraint-based phonology).[15]

SUMMARY

I have reviewed the essential structure of the metrical theory of phonology, focusing on the early arguments for it and reviewing some of the central issues that have animated the field since 1968.

The central insight has been that rules are traded for constituency. Rather than a derivational approach to stress, in which some *n*-nary stress feature is assigned to domains, constituents are aligned with strings. The proper alignment of these constituents is governed by a restricted set of algorithms, which can be conceived of in terms of a ranked set of violable constraints. Most of the debates within the field have centered on the nature of these constituents

[15] Startlingly, nothing has appeared to date in any of the major linguistics journals. However, most of the circulating papers are available via anonymous ftp from the Rutgers Cognitive Science Center (ruccs.rutgers.edu).

and the disparate kinds of evidence that can be adduced in support of different versions of metrical structure.

The past two years have seen a dramatic shift away from constituency to a focus on how the constituents get placed. The leading idea being explored today is that constituents are not placed by specific rules. Rather, a candidate set of constituentized representations is generated and then winnowed through by the language-specific constraint hierarchy.

It is impossible to predict the future, but I suspect that the constraint-based view will continue to be explored and that there will be less reliance on constituents as constraint-based theory is elaborated. However, it seems rather unlikely that the constraint-based view will completely supplant the rule-based view, and I hope a happy medium will develop.

ACKNOWLEDGMENTS

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Literature Cited

1. Al-mozainy HQ, Bley-Vroman R, McCarthy J. 1985. Stress shift and metrical structure. *Linguist. Inq.* 16:135–44
2. Anderson SR. 1985. *Phonology in the Twentieth Century*. Chicago: Univ. Chicago Press
3. Austin P. 1981. *A Grammar of Diyari*. Cambridge: Cambridge Univ. Press
4. Bowen JD. 1965. *Beginning Tagalog*. Berkeley: Univ. Calif. Press
5. Broselow E, McCarthy J. 1983. A theory of internal reduplication. *Linguist. Rev.* 3: 25–88
6. Chai N. 1971. *A grammar of Aklan*. PhD thesis. Univ. Penn., Philadelphia
7. Chomsky N. 1965. *Aspects of the Theory of Syntax*. Cambridge, MA: MIT Press
8. Chomsky N, Halle M. 1968. *The Sound Pattern of English*. New York: Harper & Row
9. Chung S. 1983. Transderivational relationships in Chamorro phonology. *Language* 59:35–66
10. Crowhurst M. 1993. *Minimality and foot structure in metrical phonology and prosodic morphology*. PhD thesis. Univ. Ariz., dist. by Indiana Univ. Linguist. Club
11. Davis S. 1985. Syllable weight in some Australian languages. *Berkeley Linguist. Soc.* 11:398–407
12. Dixon RMW. 1977. Some phonological rules of Yidin^y. *Linguist. Inq.* 8:1–34
13. Dixon RMW. 1977. *A Grammar of Yidin^y*. Cambridge: Cambridge Univ. Press
14. Fitzgerald C. 1994. Ternary stress in optimality theory. Univ. Ariz., Dep. Linguist., Tucson, Unpublished ms.
15. French KM. 1988. *Insights into Tagalog reduplication. infixation and stress from non-linear phonology*. Masters thesis. Univ. Texas, Arlington
16. Goddard I. 1982. The historical phonology of Munsee. *Int. J. Am. Linguist.* 48:16–48
17. Hagberg L. 1993. *An autosegmental theory of stress*. PhD thesis. Univ. Ariz., Tucson
18. Halle M. 1987. Grids and trees in metrical phonology. In *Phonologica 1984*, ed. WU Dressler, HC Luschützky, OE Pfeiffer, JR Rennison, pp. 79–94. Cambridge: Cambridge Univ. Press
19. Halle M. 1994. New England dialects paper. MIT, Dep. Linguist., Unpublished ms.
20. Halle M, Kenstowicz M. 1991. The free element condition and cyclic versus noncyclic stress. *Linguist. Inq.* 22:457–501
21. Halle M, Vergnaud JR. 1978. Metrical

structures in Phonology. MIT, Dep. Linguist., Unpublished ms.

22. Halle M, Vergnaud JR. 1987. *An Essay on Stress*. Cambridge, MA: MIT Press
23. Hammond M. 1984. *Constraining metrical theory: a modular theory of rhythm and destressing*. PhD thesis. UCLA; Revised version dist. by Indiana Univ: Linguist. Club. 1988. New York: Garland
24. Hammond M. 1985. Obligatory branching revisited. *Northeast. Linguist. Soc.* 15:145–67
25. Hammond M. 1985. Main stress and parallel metrical planes. *Berkeley Linguist. Soc.* 11:417–28
26. Hammond M. 1986. The obligatory-branching parameter in metrical theory. *Nat. Lang. Linguist. Theory* 4:185–228
27. Hammond M. 1987. Accent, constituency, and lollipops. *Chicago Linguist. Soc.* 23 (2):149–66
28. Hammond M. 1987. Hungarian cola. *Phonology* 4:267–70
29. Hammond M. 1987. Destressing rules in metrical theory. *Milwaukee Stud. Lang.* 1: 76–102
30. Hammond M. 1989. Lexical stresses in Macedonian and Polish. *Phonology* 6: 19–38
31. Hammond M. 1989. Cyclic secondary stress and accent in English. *West Coast Conf. Formal Linguist.* 8:139–53
32. Hammond M. 1991. *Metrical Theory and Learnability*. Univ. Ariz., Dep. Linguist., Unpublished ms.
33. Hammond M. 1991. Poetic meter and the arboreal grid. *Language* 67:240–59
34. Hammond M. 1995. Deriving ternarity. *Coyote Pap.* In press
35. Hammond M, Noonan M, eds. 1988. *Theoretical Morphology*. San Diego: Academic
36. Harris J. 1983. *Syllable Structure and Stress in Spanish*. Cambridge, MA: MIT Press
37. Hayes B. 1981. *A metrical theory of stress rules*. PhD thesis; Revised version dist. by Indiana Univ. Linguist. Club. 1984. New York: Garland
38. Hayes B. 1982. Metrical structure as the organizing principle of Yidin[y] phonology. In *The Structure of Phonological Re*presentations, Part I, ed. H van der Hulst, N Smith. Cinnaminson, Germany: Foris
39. Hayes B. 1982. Extrametricality and English stress. *Linguist. Inq.* 13:227–76
40. Hayes B. 1983. The role of metrical trees in rhythmic adjustment. *Northeast. Linguist. Soc.* 13:105–20
41. Hayes B. 1983. A grid-based theory of Enlish meter. *Linguist. Inq.* 14:357–93
42. Hayes B. 1984. The phonology of rhythm in English. *Linguist. Inq.* 15:33–74
43. Hayes B. 1985. Iambic and trochaic rhythm in stress rules. *Berkeley Linguist. Soc.* 11: 429–46
44. Hayes B. 1987. A revised parametric metrical theory. *Northeast. Linguist. Soc.* 17: 274–89
45. Hayes B. 1989. The prosodic hierarchy in meter. See Ref. 60, pp. 201–60
46. Hayes B. 1994. *Metrical Stress Theory*. Chicago: Univ. Chicago Press
47. Hyman LM. 1977. On the nature of linguistic stress. See Ref. 48, pp. 37–82
48. Hyman LM, ed. 1977. *Studies in Stress and Accent. South. Calif. Occas. Pap. Linguist.*, Vol. 4. Los Angeles: Dep. Linguist., Univ. South. Calif.
49. Idsardi WJ. 1992. *The computation of prosody*. PhD thesis. MIT
50. Kager R. 1989. *A Metrical Theory of Stress and Destressing in Dutch and English*. Dordrecht: Foris
51. Kager R. 1993. Consequences of catalexis. *Proc. HIL Conf. Phonology, 1st*
52. Kager R. 1994. Deriving ternary rhythm in alignment theory. Utrecht Univ., Unpublished ms.
53. Kenstowicz M. 1981. *The metrical structure of Arabic accent*. Presented at UCLA/USC Nonlinear Phonol. Conf.
54. Kenstowicz M. 1983. Parametric variation and accent in the Arabic dialects. *Chicago Linguist. Soc.* 19:205–13
55. Key H. 1961. Phonotactics of Cayuvava. *Int. J. Am. Linguist.* 27:143–50
56. Key H. 1967. *Morphology of Cayuvava*. Hague: Mouton
57. Kiparsky P. 1977. The rhythmic structure of English verse. *Linguist. Inq.* 8:189–247
58. Kiparsky P. 1979. Metrical structure assignment is cyclic. *Linguist. Inq.* 10: 421–41
59. Kiparsky P. 1991. Catalexis. Stanford Univ., Dep. Linguist., Unpublished ms.
60. Kiparsky P, Youmans G, eds. 1989. *Rhythm and Meter*. San Diego: Academic
61. Kisseberth CK. 1972. On derivative properties of phonological rules. In *Contributions to Generative Phonology*, ed. MK Brame, pp. 201–28. Austin: Univ. Texas Press
62. Lehiste I. 1970. *Suprasegmentals*. Cambridge, MA: MIT Press
63. Levin J. 1988. Generating ternary feet. *Texas Linguist. Forum* 29:97–114
64. Levin J. 1988. Bidirectional foot construction as a window on level ordering. See Ref. 35, pp. 339–52
65. Liberman M. 1975. *The intonational system of English*. PhD thesis. MIT
66. Liberman M, Prince A. 1977. On stress and linguistic rhythm. *Linguist. Inq.* 8:249–336
67. Lombardi L, McCarthy J. 1991. Prosodic circumscription in Choctaw morphology. *Phonology* 8:37–71

68. Lynch J. 1974. *Lenakel phonology*. PhD thesis. Univ. Hawaii. *Univ. Hawaii Work. Pap. Linguist.* 7
69. Marantz A. 1982. Re reduplication. *Linguist. Inq.* 13:435–82
70. McCarthy J. 1979. *Formal problems in Semitic phonology and morphology*. PhD thesis. MIT. dist. by Indiana Univ. Linguist. Club
71. McCarthy J. 1982. Prosodic structure and expletive infixation. *Language* 58:574–90
72. McCarthy J, Prince A. 1986. Prosodic Morphology. Univ. Mass./Brandeis Univ., Dep. Linguist., Unpublished ms.
73. McCarthy J, Prince A. 1990. Foot and word in prosodic theory: the Arabic broken plural. *Nat. Lang. Linguist. Theory* 8:209–82
74. McCarthy J, Prince A. 1993. Prosodic Morphology I. Univ. Mass./Rutgers Univ., Dep. Linguist., Unpublished ms.
75. Mester RA. 1994. The quantitative trochee in Latin. *Nat. Lang. Linguist. Theory* 12: 1–61
76. Moravcsik E. 1978. Reduplicative constructions. In *Universals of Human Language*, Vol. 3, *Word Structure*, ed. JH Greenberg. Stanford, CA: Stanford Univ. Press
77. Nespor M, Vogel I. 1979. Clash avoidance in Italian. *Linguist. Inq.* 10:467–82
78. Phinnemore TR. 1985. Ono phonology and morphophonemics. *Pap. New Guinea Linguist.* 22:173–214
79. Prince A. 1975. *The Phonology and morphology of tiberian hebrew*. PhD thesis. MIT, Cambridge, MA
80. Prince A. 1983. Relating to the grid. *Linguist. Inq.* 14:19–100
81. Prince A. 1991. Quantitative consequences of rhythmic organization. *Chicago Linguist. Soc.* 26
82. Prince A, Smolensky P. 1993. Optimality theory. Rutgers Univ./Univ. Colo., Dep. Linguist./Comp. Sci., Unpublished ms.
83. Rice C. 1992. *Binarity and ternarity in metrical theory: parametric extensions*. PhD thesis. Univ. Texas, Austin
84. Rischel J. 1972. Compound stress in Danish without a cycle. *Annu. Rep. Inst. Phonet. Univ. Copenhagen* 6:211–28
85. Schane SA. 1979. Rhythm, accent, and stress in English. *Linguist. Inq.* 10:483–502
86. Selkirk EO. 1980. The role of prosodic categories in English word stress. *Linguist. Inq.* 11:563–605
87. Selkirk EO. 1984. *Phonology and Syntax*. Cambridge, MA: MIT Press
88. Spring C. 1989. Dactyls in Cayuvava. Univ. Ariz., Dep. Linguist., Unpublished ms.
89. Stowell T. 1979. Stress systems of the world unite! *MIT Work. Pap. Linguist.* 1: 51–76
90. Street JC. 1963. *Khalkha Structure*. Bloomington: Ind. Univ. Publ.
91. Strehlow TGH. 1942. Arandic phonetics. *Oceania* 7:255–302
92. Tryon DT. 1970. *An Introduction to Maranungku. Pacific Linguist. Monogr. Ser. B*, No. 14. Canberra: Aust. Nat. Univ.
93. Voegelin C. 1935. *Tübatulabal Grammar*. Berkeley: Univ. Calif. Press

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