North East Linguistics Society

Volume 17 *Proceedings of NELS 17 -- Volume 1* Article 18

1986

A Revised Parametric Metrical Theory

Bruce Hayes
UCLA

A Revised Parametric Metrical Theory

Bruce Hayes

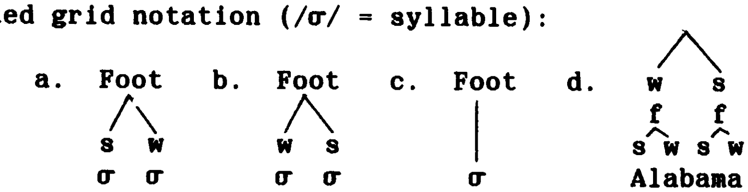
UCLA

1. Outline and Preliminaries. The rules used by languages to assign word stress show a remarkable formal variety. The intent of a parametric theory of stress (first proposed by Halle and Vergnaud 1978) is to express unifying formal principles that underlie this surface diversity. Under a parametric theory, every stress rule is encoded as the setting of a limited inventory of parameters, provided under universal grammar. A parametric stress theory is successful to the extent that it achieves the following aims: (a) Every attested stress rule is characterizable as some set of parameter settings. (b) The parameters significantly restrict the range of possibilities; i.e. make nontrivial predictions. (c) All general patterns of stress predicted by the theory are empirically attested in some version; i.e. there are no gaps in the data. This paper is a sketch of a revised parametric metrical theory, taken from Hayes (in progress). I will try to show that the revised theory is an improvement in several respects over the theory I proposed in Hayes (1981).

The discussion here will be restricted to bounded stress systems, defined as those which limit the maximum distance from a stress to another stress or to the word edge. These appear to pose the great empirical challenge to a parametric theory. For accounts of unbounded systems, see Prince (1985), Halle and Vergnaud (forthcoming).

As a formalism for representing stress, I use "bracketed grids," which are a modified version of formalisms developed in Hammond (1984) and Halle and Vergnaud (forthcoming). In a bracketed grid, parentheses are used to depict the constituent structure posited in tree-based versions of metrical theory (e.g. Liberman and Prince 1977, Hayes 1981). Prominence relations are depicted essentially as in grid theories of stress (Prince 1983, Selkirk 1984), using columns of /x/'s. To save space, I use grid columns of zero height, marked with /./, for stressless syllables. To illustrate bracketed grids, here are some corresponding structures in tree and bracketed grid notation (/σ/ = syllable):

(1) Tree theory:



Bracketed Grid Equivalent:

```
a. (x  .)     b. (.  x)     c. (x)     d. (      x  )
    σ  σ          σ  σ          σ         (x .)(x .)
                                           Ala  bama
```

The basic idea of the theory is to capture the generalizations made by both tree and grid theories, without positing two simultaneous representations for stress. My intent here is not to present arguments for the theory itself (for these see Hammond (1984), Halle and Vergnaud (forthcoming), Hayes (in progress)), but rather to develop a specific proposal within the theory.

2. The Theory of Hayes (1981) and its Drawbacks. To begin, I will review an earlier proposal for a parametric metrical theory, which I made in my dissertation (Hayes 1981). In this theory, stress rules are viewed as parsing algorithms, which group the syllables of a word into metrical structure. For purposes of bounded stress rules, the crucial parameters of the theory are those listed under (2):

(2) Parameters for Bounded Stress Rules (Hayes 1981)

a. At which edge of the word does the rule begin parsing? (left/right)
b. Does the rule construct just one foot, or does it parse the whole word? (non-iterative/iterative)
c. Which side of the foot is strong? (left/right)
d. Is the rule quantity-sensitive; that is, is a heavy syllable forbidden to appear on the weak side of a foot? (yes/no)

Of these parameters, I will focus on (2c) and (2d). Since these binary parameters are independent, they yield four distinct logical possibilities, each corresponding to a different stress pattern. In what follows, it will be useful to consider these four possibilities separately. Below, they are spelled out as foot construction algorithms, using the following notation: /σ/ = any syllable, /-/ = heavy syllable, and /⌣/ = light syllable, according to the specific criterion of syllable weight used in the language.

(3) The Four Algorithms Resulting from (2c,d)

I. Quantity-insensitive, left dominant

```
      (x .)                            (x)
Form   σ σ  if possible; otherwise form σ .
```

II. Quantity-insensitive, right dominant

```
      (. x)                            (x)
Form   σ σ  if possible; otherwise form σ .
```

III. Quantity-sensitive, left dominant

```
      (x .)                            (x)
Form   σ ⌣  if possible; otherwise form σ .
```

IV. Quantity-sensitive, right dominant

```
      (. x)                            (x)
Form   ⌣ σ  if possible; otherwise form σ .
```

To illustrate how the algorithms work, I give some representative parsings below from Maranungku (3.I) and Munsee (3.IV). In both languages, there is an additional rule which constructs a higher level of structure, assigning main stress to one of the lower-level grid marks.

(4) An Example of (3.I): Maranungku (Australia, Tryon 1970)

Parse according to I from left to right, assigning main stress to the initial foot.

```
a. (x             )                 b. (x             )
   (x .)(x .)(x .)                     (x   .)(x .)(x)
    σ σ  σ σ  σ σ                       σ    σ  σ σ  σ
   wéle pène mànta  'kind of duck'     lángka râte tì    'prawn'
```

(5) Example of (3.IV): Munsee (Algonquian, Goddard 1982)

Parse according to IV from left to right, then give main stress to the penultimate foot (light = CV, heavy = CVC, CVV).

```
a. (       x     )
   (. x)(. x)(. x)
    ⌣ ⌣  ⌣ ⌣  ⌣ ⌣
   nəkà kətá kəkà      'I do a fast dance'
```

```
b. (          x     )        c. (                      x   )
   (. x)(. x)(x)(. x)           (. x)(x)(. x)(x)(. x)(x)
    ⌣ –  ⌣ ⌣  –  ⌣ –             ⌣ ⌣  –  ⌣ ⌣  –  ⌣ ⌣  –
   səkâhtakə̃ nîikanàl  'reins'  nəsə̃ kâhtakə̃ nìikanə̃ màl  'my reins'
```

North East Linguistics Society, Vol. 17 [1986], Art. 18

The Hayes (1981) theory suffers from various theoretical and empirical problems.

First, to handle a number of systems, the theory must invoke additional formal devices; in particular, it must posit rules that label structures for prominence based on whether or not they branch (see below). But Prince (1983) has argued cogently that this kind of rule can be eliminated from metrical theory, to be replaced by the device of extrametricality. The particular parametric theory I proposed is incompatible with this highly desirable simplification of general metrical theory.

Second, the Hayes (1981) theory predicts that in the absence of additional factors, such as extrametricality or destressing rules, the stresses in a bounded system will fall at most two syllables from each other or from word edge. But there exist systems in which the maximum interstress distance is three syllables, not two. Moreover, in these languages, the ternary intervals are basic to the system and not the result of additional factors. Such languages, which include Cayuvava (Key 1967), Mantjiltjara (Marsh 1969), Winnebago (Miner 1979), Estonian (Prince 1980), and Finnish (Harms 1964), are clear exceptions to the theory.

Third, and for present purposes most important, the theory suffers from "data gaps"; that is, it predicts as ordinary cases systems that are either never found, or else are quite rare. There are two such data gaps.

The first concerns the quantity-sensitive algorithms, (3.III) and (3.IV). The algorithm of (3.IV) is applied iteratively in many languages,[1] but its mirror image, (3.III), is to my knowledge never applied iteratively. The only languages for which (3.III) has been invoked are languages with non-iterative stress, such as Latin.

The second data gap involves the quantity-insensitive algorithms. This gap is statistical rather than absolute, but it is backed up empirically by a larger number of cases. While algorithm (3.I) is applied iteratively in many languages, (3.II), its mirror image, is seldom applied iteratively.[2] Moreover, by invoking mechanisms that appear to be independently necessary--extrametricality and monosyllabic feet--it is possible to reanalyze the (3.II) cases as (3.I) cases. The reanalyses are more complex, but this seems justified, in that it provides a formal account of the apparently

---

[1] See Hayes (1985) for documentation. To the examples adduced there (fifteen languages from five different families) can be added two examples I have found since then: Cyrenaican Bedouin Arabic (Hayes 1986) and Negev Bedouin Arabic (Blanc 1971).

[2] In Hayes (1985), I counted 32 cases of (3.I) and five cases of (3.II).

more marked status of these stress systems.

3. A Revised Theory. This paper is excerpted from a larger work in progress, which attempts to remedy the criticisms above with a better theory. Because of space considerations, here I will address only two of the criticisms: the data gaps just noted, and the requirement for labeling based on branching. Some notions that will be needed are as follows.

First, I assume a theory of extrametricality rules (see Hayes 1981; 1982, Harris 1982, and subsequent work). Such rules specify that a given constituent (e.g. a syllable, segment, suffix, or foot) is specified as "invisible" to the stress rules when it occurs at the right edge of the word. I will mark extrametricality with underlining.

Second, I introduce the notion of a "stressless foot," depicted as a monosyllabic constituent lacking a grid mark:

```
(6)  (.)
      σ
```

A stressless foot is phonetically interpreted in the same way as an ordinary stressless syllable. The two are phonologically distinct, however, in that among other things, a stressless foot can undergo a foot extrametricality rule.

Third, I will make use of the commonplace notion of mora, symbolized with /m/. The simplest definition of a mora is McCawley's (1977): "something of which a heavy syllable consists of two and a light syllable consists of one;" for a more formalized account, see Prince (1983).

Last, I borrow some terminology from traditional metrics: an iamb is a disyllabic foot with final stress, a trochee a disyllabic foot with initial stress.

```
(7)            (. x)              (x .)
      Iamb:     σ σ     Trochee:   σ σ
```

In a rule of foot construction, "disyllabic" should be taken to mean "disyllabic if conditions permit; otherwise monosyllabic." This follows earlier practice in metrical theory.

The basic intent of my proposal is to address and correct the data gaps encountered by parameters (2c) and (2d). Because these parameters make no reference to direction, they wrongly predict that the data will be symmetrical. My proposal is to scrap these parameters, and replace them with an asymmetrical inventory of basic metrical units. The asymmetry in the inventory will be seen to account for the asymmetry in the data.

The inventory I propose contains the following elements:

(8)

A. Syllabic Trochee: Form
(x .)
σ σ if possible; otherwise form
(.)
σ .

B. Moraic Trochee: Form
(x .)
m m if possible, where
(x .)
m m is either
(x .)
˘ ˘ or
(x)
– ; otherwise form
(.)
˘ .

C. Iamb: Form
(. x)
˘ σ if possible, otherwise form
(x)
– or
(.)
˘ .

Observe that this inventory has three members, rather than the four generated by parameters (2c,d). The theory is thus slightly "less parametric," as it replaces the four possibilities generated by two binary parameters with an list that cannot be broken down any further. Some justification for this move appears below.

In illustrating how the theory works, the easiest place to start is with a match-up between the old and new systems, showing what does the work of what. My discussion is illustrated by chart (9), below. The syllabic trochee (8.A) is very similar to (3.I) (quantity-insensitive left dominant), and would do the same descriptive work. The syllabic trochee also handles the functions of (3.II) (quantity-insensitive right dominant). As already noted, to do this, it must be supplemented with additional rules; this correctly characterizes the marked status of stress systems in question. The moraic trochee (8.B), which is vaguely similar to (3.III) (quantity sensitive left dominant), can be made to handle the same descriptive functions. As as we will see below, it can also describe systems which (3.III) is unable to describe. Finally, the iamb (8.C) closely resembles (3.IV) (quantity sensitive right dominant), and treats the same systems.

(9) Match-ups with Earlier Theory

(8.A) Syllabic Trochee — (3.I) — (3.II)

(x .) (.)
σ σ else σ <--->
(x .) (x)
σ σ else σ and
(. x) (x)
σ σ else σ

(8.B) Moraic Trochee — (3.III)

(x .) (x) (.)
˘ ˘ or – else ˘ <--->
(x .) (x)
σ ˘ else σ

and others (see below)

(8.C) Iamb — (3.IV)

(. x) (x) (.)
˘ σ else – or ˘ <--->
(. x) (x)
˘ σ else σ

Clearly the most novel element in the system is the moraic trochee. To give an example of a stress system that uses moraic trochees, I will present an outline analysis of stress in Palestinian Arabic. Data are taken from Kenstowicz (1981, 1983).

Syllables in Palestinian can be divided into heavy (CVC or CVV) and light (CV), following the usual definition. The basic stress rule for Palestinian is stated verbally as follows:

(10)a.	Stress the penult if it is heavy.	makáatib	'offices'
		mooládna	(--> moládna) 'our feast'
b.	In a word having exactly four light syllables, stress the initial syllable.	ḍárabato	(--> ḍárbato) 'she hit him'
c.	In all other cases, stress the third syllable from the end.		
	1. Exactly three lights	bákara	'cow'
	2. Exactly five lights	šaǰarátuhu	'his tree'
	3. Heavy plus three lights	baarákato	'she blessed him'
	4. Words ending in heavy-light-light	báarako	'he blessed him'[3]

The mechanism of moraic trochees makes possible a straightforward analysis of these data, as follows:

(11)a.	Foot Construction:	From left to right, parse a word into moraic trochees.
b.	Foot Extrametricality:	Mark the rightmost foot as extra-metrical.
c.	Main Stress:	Form a higher-level constituent, assigning its grid mark by End Rule Right.

I assume that End Rule Left/Right (Prince 1983) is the sole mechanism available for labeling higher-level structure; it places an /x/ on top of the left/rightmost visible /x/ in the domain.

Here are some examples of words taken from (10), correctly stressed by the rules above. The stages shown for each derivation are the output of Foot Construction, Foot Extrametricality, and Main Stress Assignment.

---

[3] Some notes on the data: all colloquial words having four underlying light syllables, such as /ḍarabato/, undergo syncope processes following stress assignment. The pre-antepenultimate stress assigned to this class can be seen pristinely in native pronunciations of Classical Arabic words, such as šáǰaratun 'a tree' (where the final /n/ is extrametrical). šaǰarátuhu is also a Classical word stressed natively.

```
(12)                                                           (x          )
                       (x .)(x .)        (x .)(x .)            (x .)(x .)
          ˘ ˘ ˘ ˘      ˘ ˘  ˘ ˘          ˘ ˘  ˘ ˘              ˘ ˘  ˘ ˘
  (10b) ḍarabato  -->  ḍara bato   -->   ḍara bato    -->      ḍára bato

                                                               (    x      )
                       (x .)(x .)(.)     (x .)(x .)(.)         (x .)(x .)(.)
          ˘ ˘ ˘ ˘ ˘    ˘ ˘  ˘ ˘  ˘       ˘ ˘  ˘ ˘  ˘           ˘ ˘  ˘ ˘  ˘
(10c.2) šaǰaratuhu ->  šaǰa ratu hu  ->  šaǰa ratu hu  ->      šaǰa rátu hu

                                                               (  x      )
                       (x)(x .)(.)       (x)(x .)(.)           (x)(x .)(.)
          - ˘ ˘ ˘      -  ˘ ˘  ˘         -  ˘ ˘  ˘             -  ˘ ˘  ˘
(10c.3) baarakato -->  baaraka to   -->  baaraka to    -->     baaráka to

                                                               (x      )
                       (x .)(.)          (x .)(.)              (x .)(.)
          ˘ ˘ ˘        ˘ ˘  ˘            ˘ ˘  ˘                ˘ ˘  ˘
(10c.1) bakara    -->  baka ra      -->  baka ra       -->     báka ra

                                                               (x      )
                       (x)(x .)          (x)(x .)              (x)(x .)
          - ˘ ˘        -  ˘ ˘            -  ˘ ˘                -  ˘ ˘
(10c.4) baarako   -->  baarako      -->  baarako       -->     báarako

                                                               (  x  )
                       (x)(x)(.)         (x)(x)(.)             (x)(x)(.)
          - - ˘        -  - ˘            -  - ˘                -  - ˘
  (10a) mooladna  -->  mooladna     -->  mooladna      -->     mooládna
```

Hayes (in progress) includes a number of cases from other languages in which moraic trochees provide a simple account of stress patterns whose verbal descriptions are complex: Maithili (Jha 1958), Bhojpuri (Shukla 1981), and Turkish toponyms (Sezer 1981, Kaisse 1985).

4. Arguments. In this section I present three reasons why the new foot inventory should be preferred to the old.

4.1 Eliminating Data Gaps. As it was designed to do, the new system correctly describes the asymmetries found cross-linguistically in bounded iterative stress assignment. It does this by eliminating those foot templates that aren't assigned iteratively, namely (3.II) and (3.III). The new system is fully instantiated among iterative systems, with multiple examples in each category. This is shown under (10), where I provide examples for both left-to-right and right-to-left foot construction, for all three foot templates.

(13)	Left to Right	Right to Left
Syllabic Trochee	Maranungku ((4) above) Hungarian (Hammond 1986)	Warao (Osborn 1966) Garawa (Furby 1974)
Moraic Trochee	Palestinian Arabic Cairene Arabic (below)	Maithili (Jha 1958) Turkish toponyms (Sezer 1981)
Iamb	Aklan (Hayes 1981) Tübatulabal (Voegelin 1935)	Munsee ((5) above) Cyrenaican Bedouin Arabic (Hayes 1986)

What of the cases that were handled under the foot templates that I propose to abolish? For template (3.II), I have already suggested an answer, namely that slightly more complex analyses using other devices are always available. For template (3.III), the only relevant cases involve non-iterative foot construction. A minor modification to the theory can bring these cases into line. In particular, we must assume that "non-iterative" foot construction means "iterate until a stress is assigned." This allows us to analyze the old (3.III) languages with moraic trochees instead. Below I show this with schematic examples for one of the relevant languages, Classical Latin. Note that final syllables in Latin are extrametrical.

(14) Latin Stress

From right to left, construct moraic trochees non-iteratively (i.e. until a stress is assigned).

```
a. (x .)        b.  (x)        c.  (x)        d. (x)(.)
   ⌣ ⌣ σ #         ⌣ - σ #       - - σ #          -  ⌣ σ #
```

The revised definition of "non-iterative" I am proposing appears to cause no problems elsewhere, and in fact may be helpful in describing systems of the "obligatory branching" type as well; see Hayes (1981; in progress).

The result of this discussion is that the revised foot inventory of (8) appears to be capable of replacing the old inventory of (3) in all of its functions, at the same time making valid predictions that the old inventory failed to make.

4.2 The Diagnostic of Foot Extrametricality. Moraic trochees differ from (3.III) (their closest counterpart in the old system) in how they parse word final sequences of the form /- ⌣/. No matter what direction parsing proceeds in, the following results are obtained:

```
(15)
                                (x)(.)            (x .)
   Moraic trochees (8.III):     -  ⌣ #   (3.III):  - ⌣  #
```

This difference gives rise to an argument in favor of the new system. Suppose a language has foot extrametricality and End Rule Right. Under the new system, the final syllable is a foot on its own. It will be marked extrametrical, and stress will fall on the immediately preceding grid mark; hence on the penultimate syllable. Under the old system, with the (3.III) trochees, the entire sequence /– ᴗ/ is a foot, and will be extrametrical. The penult will be skipped over, and the closest grid mark to its left (whatever that is) will receive main stress. The contrast between the predictions of the two systems is shown schematically below:

(16)a. <u>Moraic Trochees</u>   b. <u>(3.III)</u>

```
        x  )                 x        )
       (x)(.)                x ...)(x .)
   ...  –  ᴗ #               σ ...  – ᴗ #
```

There are four languages of which I am aware in which these contrasting predictions can be tested: Palestinian Arabic, Maithili, Bhojpuri, and Turkish. In all of the them, the predictions of the new theory are confirmed. An example of the relevant sort is given below for Palestinian:

```
(17)  (  x  )       (x      )
      (x)(x)(.)     (x)(x  .)
       –  –  ᴗ       –  –  ᴗ
      moolâdna,  not  *móoladna
```

4.3 <u>Eliminating Labeling Based on Branching</u>. Early versions of metrical theory frequently invoked a rule schema in which an arboreal node was labeled strong if and only if branches. For example, the word trees for English nouns were labeled "right strong iff branching" in Liberman and Prince (1977); cf. (18a). There would be little difficulty in carrying over such rules into bracketed grid theory, as (18b) suggests.

```
         /\        /\
(18)a.  s  W      w  S        (x     )  (     x  )
       s^w |     s^w s^w      (x .)(x)  (x .)(x .)
      Isidore   Isidora   =    Isidore   Isi dora
```

However, Prince (1983) argued that given the independently-needed theory of extrametricality, labeling based on branching is dispensable; the rule schema End Rule Right/Left suffices for all labeling of higher level structure.

This is clearly a positive result, but the theory proposed in Hayes (1981) stands in the way of it. In particular, for the well-known case of Cairene Arabic (McCarthy 1979), there is no way to account for the data under the old theory without invoking labeling based on branching. In outline, here are the Cairene facts:

(19) Cairene Arabic Stress (Mitchell 1960, McCarthy 1979)

a. Stress a heavy penult.
b. Otherwise, stress either the penult or the antepenult, whichever is separated by an even number of light syllables (including zero) from the rightmost heavy syllable, or from the left word boundary in words lacking heavy syllables.

The account of Cairene stress in Hayes (1981) is fairly complicated; I will not review it here, except to note that it invokes labeling based on branching twice. At the foot level, the only available analytical option is to posit feet of the type (3.IV), labeled right strong iff branching. At the word level, right strong iff branching is again adopted, following McCarthy (1979)'s account. The kind of reference to branching that is involved appears to be difficult to replicate by positing a rule of extrametricality.

The upshot of this is that it is impossible simultaneously to eliminate labeling based on branching, adhere to the parametric theory of Hayes (1981), and successfully analyze Cairene Arabic.

The problem disappears under the theory offered here. Assuming the existence of moraic trochees and stressless feet, the Cairene Arabic stress system turns out to be quite simple; in fact it is just the same as Palestinian Arabic, without the foot extrametricality rule. Without going into a full set of derivations, I show this below by pairing Cairene and Palestinian words that have the same syllable patterns. Note that when the rightmost foot in Cairene bears a grid mark, then the lack of extrametricality makes a difference, and the two languages assign different stress patterns. But when the rightmost foot in Cairene is stressless, its lack of extrametricality fails to influence the stress pattern. This follows from the standard assumption (Prince 1983) that grid columns must be continuous. The rightmost foot provides no "landing site" for the word level /x/, and must therefore be skipped over.

(20)

	Different		Same	
Palestinian:	(x) (x)(x .) – ˘ ˘ báarako	(x) (x .)(x .) ˘ ˘ ˘ ˘ ḍára bato	(x) (x .)(x .)(.) ˘ ˘ ˘ ˘ ˘ šaǰa rátu hu	(x) (x)(x .)(.) – ˘ ˘ ˘ baaráka to
Cairene:	(x) (x)(x .) – ˘ ˘ martába	(x) (x .)(x .) ˘ ˘ ˘ ˘ kata bítu	(x) (x .)(x .)(.) ˘ ˘ ˘ ˘ ˘ šaǰa rátu hu	(x) (x)(x .)(.) – ˘ ˘ ˘ muxtáli fa
	'mattress'	'she wrote it (m.)'	'his tree'	'different (f. sg.)'

Representations like those of (21), with final main stress, would be ill-formed:

```
(21)  *(          x)     *(       x)
       (x .)(x .)(.)      (x)(x .)(.)
        ˘ ˘  ˘ ˘  ˘        –  ˘ ˘  ˘
       šaǰa ratu hú       muxtali fá
```

In summary, the new theory, unlike the old, allows us to analyze Cairene while adhering to Prince's proposal to eliminate labeling based on branching. It may be worthwhile to make clear just why the revised theory succeeds. The elimination of labeling with respect to branching at the <u>foot</u> level is made possible by the introduction of moraic trochees; these put grid marks in the right places without requiring a non-standard foot labeling. The elimination of labeling with respect to branching at the <u>word</u> level is a consequence of including stressless feet in the theory. In particular, where a right node was non-branching under the old theory, there is now a stressless foot, which cannot receive main stress, because of the ban on discontinuous columns. The two accounts of Cairene word level structure are contrasted below:

```
(22)a. Hayes (1981)          b. Present Proposal    (N.B. *(     x)
          /\                                                (x .)(.)
         s  w                   (x      )                    ˘ ˘  ˘
        s^w |                   (x .)(.)                    kata ba
        ˘ ˘ ˘                    ˘ ˘  ˘
       kátaba                   káta ba               is ill-formed.)

       (ba is non-branching.)  (ba is a stressless foot.)
```

Note finally that the present analysis is similar to McCarthy's original (1979) account. The differences involve exhaustive parsing of syllables into feet, the elimination of reference to branching at the word level, and the integration of the analysis into a general parametric theory.

4.4 <u>Summary</u>. I have proposed to eliminate parameters (2c,d) from the parametric metrical theory proposed in Hayes (1981), replacing them with the inventory under (8). There are three arguments in favor of the revised inventory: it correctly describes the asymmetries found cross-linguistically in alternating stress patterns; it correctly predicts the outcome of certain foot extrametricality rules; and it makes it possible to carry through Prince's idea of eliminating labeling with respect to branching.

5. <u>Speculation and Conclusion</u>. Theories that have internal symmetry, such as the one I proposed in Hayes (1981), need only be defended against the data. But when a theory is internally asymmetrical, one seeks a further explanation for why an asymmetry should exist. The foot inventory which I have proposed is asymmetrical in two senses: no template is paired with its mirror image, and the inventory as a whole is not the result of two independent, intersecting parameters. In this final section I offer a somewhat speculative explanation for this asymmetry. In doing so

I expand on an idea presented in Hayes (1985).

My explanation borrows from work in the psychology of rhythm. A long tradition of experiments (see for example Woodrow (1951)) suggests that there is a general law governing rhythmic grouping: iambic rhythm inherently involves uneven duration, with longer, more prominent elements last; whereas trochaic rhythm involves even duration. Such a result can be demonstrated by experiments like the following: subjects listen to a sequence of beeps that alternate either just in duration or just in intensity, and are asked to group the beeps into pairs. Subjects typically group as in (23), following the "law of iambic and trochaic rhythm:"

(23) <u>Subjective Grouping of Rhythmic Stimuli</u>

<u>Even duration</u>: ...[x́ x][x́ x][x́ x][x́ x][x́ x][x́ x]...

<u>Uneven duration</u>: ...[⏑ –́][⏑ –́][⏑ –́][⏑ –́][⏑ –́][⏑ –́]...

Evidence from other domains, such as music or verse recitation, also support the existence of this rhythmic law.

To invoke the iambic/trochaic law here, we must ask what "duration" might mean in a phonological context. Phonologists are agreed that deeper phonological representations are categorical, not quantitative; thus to speak of actual physical time within phonology makes little sense. However, there is a clear sense in which the categorical opposition of heavy vs. light syllables may be said to form a phonological categorization of a temporal difference. This is supported, for example, by the frequent phonological and metrical equivalence of one heavy with two light syllables. I will assume, then, that for phonological purposes syllable duration is to be equated with the binary opposition of syllable quantity.

Observe now that the foot construction algorithms that I have proposed are in a sense "designed" to satisfy the law of iambic and trochaic rhythm. In particular, the iamb maximizes the number of feet whose syllables contrast in duration, by suppressing heavy syllables in weak position. In contrast, the syllabic trochee and the moraic trochee create (where possible) feet whose syllables are phonologically equal in duration.[4] To illustrate the congruence of the foot inventory with the iambic/trochaic law, I repeat the inventory below:

---

[4] I believe that syllabic trochees are usually (though not always) found in languages in which syllable weight distinctions play no role in the phonology at all; in such languages it seems legitimate to claim that all syllables are of phonologically equal duration.

(22) Iamb			Syllabic Trochee		Moraic Trochee		
(. x)	(x)	(.)	(x .)	(.)	(x .)	(x)	(.)
⌣ σ else	– or	⌣	σ σ else	σ	⌣ ⌣ or	– else	⌣

Note that the iambic template will not always create durationally contrasting iambs by itself. For example, if a word consists of a long string of light syllables, then durationally even feet will necessarily be created. It is striking, however, that languages with "iambic" stress often have segmental phonological rules that increase the durational contrast of the foot; for example, rules that lengthen stressed vowels and reduce stressless ones (for examples and documentation see Hayes 1985).

My suggestion, then, is that the formal structures I have posited as part of a metrical stress theory may have a functional explanation, based on an extralinguistic principle of rhythmic structure. I presented this idea in Hayes (1985), but rather cautiously, as a suggestion governing only alternating stress rules. In the parametric metrical theory I have proposed here, the law of iambic and trochaic rhythm serves as the basis of the central mechanisms of bounded stress assignment.[5]

---

[5] At the NELS conference I received from its authors a copy of McCarthy and Prince (in progress), which proposes a foot inventory quite similar to what I have suggested. There are two main differences between the two treatments. McCarthy and Prince's intent is not so much to motivate the inventory typologically, but rather to use it as a partial basis for an interesting theory of "phonological measurement," which accounts for facts of reduplication and similar phenomena. Further, McCarthy and Prince attempt to characterize the foot inventory as the result of several intersecting formal principles, rather than grounding it solely in the opposition between iambic and trochaic rhythm.

References

Blanc, Haim (1971) "The Arabic Dialect of the Negev Bedouins," Proceedings of the Israel Academy of Sciences and Humanities 4, 112-150.

Furby, Christine (1974) "Garawa Phonology," Pacific Linguistics, Series A, No. 37, Australian National University, Canberra.

Goddard, Ives (1982) "The Historical Phonology of Munsee," International Journal of American Linguistics 48, 16-48.

Halle, Morris and Jean-Roger Vergnaud (1978) "Metrical Structures in Phonology," ms., Dept. of Linguistics, MIT, Cambridge, MA.

Halle, Morris and Jean-Roger Vergnaud (forthcoming) "An Essay on Stress," ms., MIT, Cambridge, MA, and University of Maryland, College Park.

Hammond, Michael (1984) Constraining Metrical Theory: A Modular Theory of Rhythm and Destressing, Doctoral dissertation, UCLA, Los Angeles, CA. [Distributed by the Indiana University Linguistics Club, Bloomington, IN.]

Hammond, Michael (1986) "Hungarian Cola," ms., Dept. of Linguistics, University of Wisconsin, Milwaukee.

Harms, Robert (1964) Finnish Structural Sketch, Indiana University, Bloomington.

Harris, James (1982) Syllable Structure and Stress in Spanish: A Nonlinear Analysis, MIT Press, Cambridge, MA.

Hayes, Bruce (1981) A Metrical Theory of Stress Rules, revised MIT doctoral dissertation, distributed by Indiana University Linguistics Club, Bloomington, Indiana. Published 1985 by Garland Press, New York.

Hayes, Bruce (1982) "Extrametricality and English Stress," Linguistic Inquiry 13, 227-276.

Hayes, Bruce (1985) "Iambic and Trochaic Rhythm in Stress Rules," Proceedings of the Berkeley Linguistic Society 11.

Hayes, Bruce (1986) "Stress Shift and Syncope in Cyrenaican Bedouin Arabic," paper given at the Winter Meeting of the Linguistic Society of America, New York.

Hayes, Bruce (in progress) Iambic and Trochaic Stress Rules, ms., UCLA, Los Angeles, CA.

Jha, Subhadra (1958) The Formation of the Maithili Language, Luzac and Co., London.

Kaisse, Ellen (1985) "Some Theoretical Consequences of Stress in Turkish," Papers from the 21st Regional Meeting of the Chicago Linguistic Society.

Kenstowicz, Michael (1981) "The Metrical Structure of Arabic Accent," paper given at the UCLA/USC Nonlinear Phonology Conference, Lake Arrowhead, CA.

Kenstowicz, Michael (1983) "Parametric Variation and Accent in the Arabic Dialects," Papers from the Nineteenth Regional Meeting of the Chicago Linguistic Society, 205-213.

Key, Harold H. (1967) Morphology of Cayuvava, Mouton, The Hague.

Liberman, Mark and Alan Prince (1977) "On Stress and Linguistic Rhythm," Linguistic Inquiry 8, 249-336.

McCarthy, John (1979) "On Stress and Syllabification," Linguistic

Inquiry 10, 443-465.

McCarthy, John and Alan Prince (in progress) "Prosodic Morphology," ms., University of Massachusetts, Amherst and Brandeis University, Waltham, MA.

McCawley, James (1977) "Accent in Japanese," in Larry Hyman, ed., Studies in Stress and Accent, University of Southern California, Los Angeles.

Marsh, James (1969) "Mantjiltjara Phonology," Oceanic Linguistics 8, 131-152.

Miner, Kenneth L. (1979) "Dorsey's Law in Winnebago-Chiwere and Winnebago Accent," International Journal of American Linguistics 45, 25-33.

Mitchell, T.F. (1960) "Prominence and Syllabification in Arabic," Bulletin of the School of Oriental and African Studies 13, 369-389.

Osborn, H.A. (1966) "Warao I: Phonology and Morphophonemics," International Journal of American Linguistics 32, 108-123.

Prince, Alan (1980) "A Metrical Theory for Estonian Quantity," Linguistic Inquiry 11, 511-562.

Prince, Alan (1983) "Relating to the Grid," Linguistic Inquiry 14, 19-100.

Prince, Alan (1985) "Improving Tree Theory," Proceedings of the Eleventh Annual Meeting of the Berkeley Linguistics Society, 471-490.

Selkirk, Elisabeth O. (1984) Phonology and Syntax: The Relation between Sound and Structure, MIT Press, Cambridge, MA.

Sezer, Engin (1981) "On Non-Final Stress in Turkish," Journal of Turkish Studies 5, 61-69.

Shukla, Shaligram (1981) Bhojpuri Grammar, Georgetown University Press, Washington, D.C.

Tryon, Darrell T. (1970) An Introduction to Maranungku, Pacific Linguistics, Series B, No. 15, Australian National University, Canberra.

Voegelin, Carl (1935) "Tübatulabal Grammar," UC Publications in American Archaeology and Ethnology 34, 55-190.

Woodrow, Herbert (1951) "Time Perception," in S. Stevens, eds., Handbook of Experimental Psychology, Wiley, New York.

Dept. of Linguistics
2113 Campbell Hall
UCLA
Los Angeles, Calif. 90024