Extrametricality in Arabic and English: Some Arguments for the Mora Tier

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0. Introduction: Overview of the Data

The earlier proposals in metrical theory such as Liberman and Prince (1977), Kiparsky (1979), Hayes (1981, 1984), Prince (1983), Selkirk (1984) etc. have recently much advanced as the theory interacts with autosegmental theory and GB theory. The main fruits to which the metrical theory owes much are "three dimensional (multi-tiered)" representation in the former and "principles-and-parameters" approach in the latter theory. Such multi-tiered and parametric metrical theory are upheld by, among others, Halle and Vergnaud (1987, henceforth H & V), Haraguchi (1987), Hayes (1987), and Tanaka (1989). 1

The present paper attempts to show that we can account for the Arabic stress naturally by introducing the mora tier and the parameter [± Moraic] into the parametric metrical theory advocated by H & V, and that by doing so we can take a fresh look at the English word stress and elaborate its extrametricality in a more judicious way.

The organization is as follows: section 1 surveys the previous treatments of the three Arabic dialects, and their problems are pointed out in section 2; and section 3 introduces the mora tier and the parameter [± Moraic] and shows a more ingenious treatment of the dialects and English. Before preceding to section 1, let us consider the descriptive generalization of the three dialects: Cairene, Palestinian, and Damascene.

The first dialect we shall illustrate is Cairene, the stress pattern of which is summarized as follows (cf. McCarthy (1979); H & V; Hayes (1987)):

(1) Cairene
   a. Stress is on the last syllable, if it is superheavy ((2a)).
b. Otherwise, stress is on the penult, if it is heavy ((2b)).
c. Otherwise, stress is on the antepenult or penult, whichever is separated by an even number of light syllables from the immediately preceding heavy syllable if there is one, or from the beginning of the word if there is none, where zero is counted as even ((2c-f)).

(2) a. sakākīn     b. ḥāqāni     c. maṭāba
d. ḥadwiyatūhumāa e. ṣaḥarātun f. ṣaḥarātuḫu

Second, the basic stress facts of Palestinian Arabic can be stated as below, following Hayes's definition (cf. Kenstowicz (1983); Hayes (1987)):

(3) Palestinian
a. Stress is on the penult, if it is heavy ((4a)).
b. In a word having exactly four light syllables, stress is on the initial syllable ((4b)).
c. In all other cases, stress is on the antepenult.
   i. Exactly three lights ((4c))
   ii. Exactly five lights ((4d))
   iii. Heavy plus three lights ((4e))
   iv. Heavy plus two lights ((4f))

(4) a. makāṭib     b. dārabato     c. bākara
d. ṣaḥarātuḫu e. baarakato f. bāarako

Finally, according to H & V, the data of Damascene word stress show the following generalization (cf. H & V):

(5) Damascene
a. Stress is on the last syllable, if it is superheavy ((6a)).
b. Otherwise, stress is on the penult, if it is heavy ((6b)).
c. Otherwise, stress is on the antepenult ((6c)).
1. Previous Analyses

In this section, we will scrutinize the previous analyses of the three dialects above. Section 1.1 surveys H & V's treatment of Cairene and Damascene; section 1.2 Hayes's of Cairene and Palestinian; and section 1.3 Roca's of Damascene.

1.1 H & V's Treatment

First, H & V usually assign line 0 asterisks to head vowels in most of languages they examine, but in Cairene they assume a special stress bearer assignment; that is, the elements over which constituent structure is constructed and which are therefore represented by line 0 asterisks are rime phonemes — in other words, the head vowels and, in the branching rime of a heavy syllable, also the phoneme immediately following the head (H & V, p.61):

\[\begin{array}{llll}
(7) & a. & \ast \ast \ast \ast \ast & b. & \ast \ast \ast \ast \ast \ast \ast \\
& ma\ rtaba & \& & \& & \& \& & Sa\jaratu\thu & \& & \& & \& & a\ dwiyatu\thuma\ a \\
& d. & \ast \ast \ast \ast \ast & e. & \ast \ast \ast \ast \\
& ha\ga\ ani & \& & \& & \& & sakaki \ i\ n
\end{array}\]

Next, H & V argue for the following definition of extrametricality (H & V, p.50):

\[\begin{array}{llll}
(8) & \text{An element marked extrametrical is invisible to the rules constructing metrical constituents only if at the point in the derivation at which these rules apply (a) the element begins or ends the phonological string and (b) does not constitute the entire string.}
\end{array}\]

and claim, following Archangeli (1986), that extrametricality of a terminal element — in this case, a word-final phoneme — percolates up to the rime node, not to the syllable node, that dominates the terminal element. However, in Cairene a special proviso must be added to the effect that the final consonant in a super-heavy syllable is not part of the rime but instead is adjoined to the syllable as a sister of the rime (H & V, p.48):
The relevant examples for the application of extrametricality are the following:

(10) a. * * * * ma rtab<ā>  b. * * * * * sājaratuh<ū>  c. * * * * * * a dwiyatuhum<āā>  
    d. * * * * hağa an<i>  e. * * * * sakaki i<n>

Note here that in (10e) extrametricality applies only to the segment m by assuming the special structure for superheavy syllables.

Moreover, the head of a branching rime (a heavy or a superheavy syllable) is supplied by the rule called Accent Rule with a line 1 asterisk (H & V, p.61):

(11) a. * * * * ma rtab<ā>  b. * * * * * sājaratuh<ū>  c. * * * * * * a dwiyatuhum<āā>  
    d. * * * * hağa an<i>  e. * * * * sakaki i<n>

Summarizing the above statements, we can get the following language-specific rules and parameter settings for Cairene, and the final derivations after their application are also given below:

(12) Cairene

  a. All phonemes in the rime are stress-bearing.
  b. Mark the last segment of the word extrametrical.
  c. Assign a line 1 asterisk to the head of each branching rime.
  d. Line 0 parameter settings are [+ HT, + BND, left, left to right].
  e. Construct constituent boundaries on line 0.
  f. Locate the heads of line 0 constituents on line 1.
  g. Line 1 parameter settings are [+ HT, - BND, right].
  h. Construct constituent boundaries on line 1.
  i. Locate the heads of line 1 constituents on line 2.
j. Conflate lines 1 and 2.

(13) a. \( \bullet \bullet \) b. \( \bullet \bullet \bullet \) c. \( \bullet \bullet \bullet \bullet \) d. \( \bullet \bullet \bullet \) e. \( \bullet \bullet \bullet \)

\( \text{ma r tab<\text{a}> saja ratuh<\text{u}> ?a d \text{wiya tuhum<\text{aa}>}} \)
\( \text{haja an<i> saka ki i<n>}} \)

The basic stress rule for Damascene is almost the same as that for Cairene, except that the stress bearer is a head vowel, not entire rime phonemes, and that the direction of line 0 constituent construction is right to left, not left to right (H & V, p.96):

(14) Damascene

a. Vowels that are heads of rimes are stress-bearing.
b. Mark the last segment of the string extrametrical.
c. Assign a line 1 asterisk to the head of each branching rime.
d. Line 0 parameter settings are [+ HT, + BND, left, right to left].
e. Construct constituent boundaries on line 0.
f. Locate the heads of line 0 constituents on line 1.
g. Line 1 parameter settings are [+ HT, - BND, right].
h. Construct constituent boundaries on line 1.
i. Locate the heads of line 1 constituents on line 2.
j. Conflate lines 1 and 2.

Given these rules and parameter settings, we can derive the stress pattern of the above words in (6) correctly:

(15) a. \( \text{darasu}^{(14e-1)} \rightarrow \text{daras<u>}^{(14d-1)} \rightarrow \text{daras<u>}^{(14c-1)} \rightarrow \text{daras<u>}} \)
b. \( \text{madaares}^{(14a-1)} \rightarrow \text{madaar<es>}^{(14d-1)} \rightarrow \text{ma daar<es>}^{(14c-1)} \rightarrow \text{ma daar<es>}} \)
1.2 Hayes(1987)'s Parametric Theory

First, as a formalism for representing stress, Hayes uses "bracketed grids" which are a modified version of formalisms developed in Hammond (1984) and H & V. 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 *'s. The following examples illustrate four kinds of foot representation assumed in Hayes's theory (for comparison, H & V's version is given in the righthand):

(16) Representation: Bracketed Grid

a. iambic (.) (.* ) cf. (.* *)
b. trochaic (*.) (.* *)
c. stressed degenerate (*) (*)
d. stressless degenerate (.)

Note that unlike H & V's, his theory contains a stressless degenerate foot. Making use of the above representation, he proposes the following foot construction, whose type and direction of application is parametrized:

(17) Foot Construction (Left to Right/Right to Left)

a. Syllabic Trochee:
Form \[ (*) \] if possible; otherwise form \[ (\cdot) \].

b. Moraic Trochee:
Form \[ (\cdot\cdot) \] if possible, where \[ (\cdot\cdot) \] is either \[ (\cdot\cdot) \]
or \[ (\cdot) \]; otherwise form \[ (\cdot) \].
c. *lamb:

Form *(.*) if possible; otherwise form (*) or (.).

Here, he refers to the commonplace notion of "mora", symbolized as m. The simplest definition of a mora is McCawley (1977)'s: "something of which a heavy syllable consists of two and a light syllable consists of one."

Second, Hayes assumes a theory of extrametricality rules (see Hayes (1981), Harris (1982), and subsequent work). Such rules specify that a given constituent (e.g. a segment, a syllable, or suffix) is specified as "invisible" to the stress rules when it occurs at the edge of a word. What is important here is that unlike others, he adopts foot extrametricality. 3

Finally, following Prince (1983), he assumes that the End Rule Left/Right is the sole mechanism available for labeling higher-level structure (i.e. assigning main stress): it places an * on the top of the left/rightmost * visible in the domain.

Given the whole system above, the stress pattern of Cairene can be captured in the following manner:

(18) Cairene (Moraic Trochee, Left to Right, End Rule Right)

a. \( \{\,*\} \) martaba
b. \( \{\,*\} \) saka kiin
c. \( \{\,*\} \) hağ aani
d. \( \{\,*\} \) šaja ratu hu

Note that the End Rule cannot put the topmost asterisk on the last foot (.) in (18c-d) because the non-consecutive vertical grids are ruled out by convention (see Prince (1983)):

(19) c'. \( \{\,*\} \)

• hağ aani
d'. \( \{\,*\} \)

• šaja ratu hu

On the other hand, Palestinian has the same stress pattern as Cairene except for foot extrametricality. Some examples are given below:
(20) Palestinian (Moraic Trochee, Left to Right, Foot Extrametricality, End Rule Right)

\[
\begin{align*}
(a) & \quad \{.,(\cdot)(\cdot)\} \\
\text{ma kaatib} & \\
(b) & \quad \{.(\cdot)(\cdot)\} \\
\text{dara bato} & \\
(c) & \quad \{.(\cdot)(\cdot)(\cdot)\} \\
\text{baaraka to} & \\
(d) & \quad \{.(\cdot)(\cdot)(\cdot)\} \\
\text{Saja ratu hu} &
\end{align*}
\]

Here, the rightmost foot is invisible to the rule assigning main stress whether it is a full foot (\(\cdot\)), a stressed degenerate foot (\(\cdot\)), or a stressless degenerate foot (\(\cdot\)).

1.3 Roca(1988)'s Distinction between Stress Bearer and Mora

Roca follows Hayes in representing stress by the bracketed grid although he does not assume a stressless foot (\(\cdot\)) and foot extrametricality. Arguably the most remarkable in his system is the separation of mora tier from stress bearer tier. This amounts to a principled separation via autosegmentalization between stress extrametricality and weight extrametricality. That is, the effect of extrametricality on stress must be represented on the stress tier while the one on syllable weight must be represented on the weight tier, and a language selects the type of extrametricality among the ones on stress bearer, mora, or both. In sum, Roca's stress theory consists of the following mechanisms:

(21) a. Mora Extrametricality
    b. Stress Bearer Extrametricality
    c. Foot Construction (= (17))
    d. End Rule Right/Left

In Damascene, extrametricality operates both on the weight plane and on the stress plane. Moreover, in the latter it is crucially restricted to light syllables, as illustrated in (22) (here, a heavy syllable is indicated as S and a light syllable s):

(22) Damascene (Mora Extrametricality, Stress Bearer Extrametricality, Moraic Trochee, End Rule Right)
In (22c) the syllable -\textit{rast} is not counted as extrametrical since it is a heavy syllable; Damascene has a language-specific condition on stress bearer extrametricality that its application is limited to a light syllable. Furthermore, it should be noted that this language has also a language-specific condition on mora extrametricality that its application is substantially limited to the second mora in a syllable, for in (22a) the syllable -\textit{su} does not become invisible to mora counting.

2. Problems

In this section, we give some problems and drawbacks seen in the three previous analyses.

First, H & V identify stress bearer line with mora line. In their theory, they usually consider line 0 as stress bearer line and align line 0 asterisks on rime heads. However, in Cairene they must specify that all rime phonemes are stress-bearing as in (12a), which is radically a counterintuitive claim because a genuine stress bearer should be a rime head only. Moreover, they must assume a special structure for superheavy syllables in (9) to make segment extrametricality to work well and a special line 1 asterisk assignment (Accent Rule), both of which are rather stipulative and should be replaced by a more principled account.

Second, Hayes's stressless foot is also stipulative and lacks a principled account since every foot in such a stress-timed language as Cairene has been considered to be, and should be, made up of at least one stressed syllable whether it is a full one or a degenerate one. Namely, when binary a foot must be, in his represen-
tation, any of (*.), (. *), and (*). Even worse, his system needs some special device to account for the following words in Cairene:

\[(23) \quad \text{a.} \quad \{\ldots\}(\ldots)(\ldots) \quad \text{b.} \quad \{\ldots\}(\ldots)(\ldots)(\ldots)\]

\* Šaja ra tun \* ?adwiya tuhu maa

According to Hayes, Cairene does not involve foot extrametricality, and a word with a final heavy syllable would always attract main stress there, but this is not the case (see (2d-e)). This leads to systematic exceptions to Hayes's system.

Finally, in accounting for Damascene stress facts, Roca must stipulate that stress bearer extrametricality is limited to a light syllable and that mora extrametricality is substantially limited to the second mora in a syllable. As shown in the following section, our system allows the stress pattern in the language to be accounted for without resorting to such language-specific conditions.

3. Refinement of the Notion 'Mora'

In this section it is shown that we can account for the Arabic stress more naturally by making use of Roca's mora tier and introducing the parameter [± Moraic] into the parametric metrical theory (section 3.1) and that given the mora tier and the parameter [± Moraic], we can take a fresh look at the English word stress and elaborate its extrametricality in the more judicious way (section 3.2).

3.1 More Natural Accounts

Our basic assumption is three-fold. First, we follow Prince (1983) in defining a mora in the following way:

\[(24) \quad \text{Assuming that long vowels are sequences,}
\text{a. The first vowel of a syllable is a mora;}
\text{b. The segment immediately following the first vowel,}
\text{if it is in the same syllable, may be a mora, sub-} \]
ject to language-specific constraints: [+ syllabic],
[+ sonorant], and no restriction.

(Prince (1983, p.52))

This formulation allows us to capture a language typology with respect to branching-sensitivity: a language in which only the first vowel can be a mora may well be considered to be branching-insensitive; and a language which also contains the second mora whether it is [+ syllabic], [+ sonorant], or no restriction can be depicted as branching-sensitive. Here, we describe the former type of language as [- Underlying Accent] (- UA) and the latter as [+ Underlying Accent] (+ UA). The relevant examples are given below, where the segment sequences aa, an, and ak may or may not be a mora according to the language in question:

(25) a. (24a)

\[
\begin{array}{cccc}
\text{a} & \text{a} & \text{a} & \text{a} \\
\text{m} & \text{m} & \text{m} & \text{m} \\
\end{array}
\]

b. (24a) + [+ syllabic]

\[
\begin{array}{cccc}
\text{a} & \text{a} & \text{a} & \text{a} \\
\text{m} & \text{m} & \text{m} & \text{m} \\
\end{array}
\]

c. (24a) + [+ sonorant]

\[
\begin{array}{cccc}
\text{a} & \text{a} & \text{a} & \text{a} \\
\text{m} & \text{m} & \text{m} & \text{m} \\
\end{array}
\]

d. (24a) + no restriction

\[
\begin{array}{cccc}
\text{a} & \text{a} & \text{a} & \text{a} \\
\text{m} & \text{m} & \text{m} & \text{m} \\
\end{array}
\]

The Arabic dialects all belong to pattern (25d).

Second, we assume that [+ UA] languages are moreover divided into two subparts with respect to the constituent construction: [+ Moraic]. In [+ Moraic] languages a heavy syllable (i.e. one with two or more morae) always construct a constituent by itself while in [- Moraic] languages this is not the case. In other words, in the former a binary foot is constructed only in the case of light-light syllable sequences regardless of the head parameter (namely, right/ left headed) while in the latter a binary foot is constructed not only in the case of heavy-light and light-light sequences when left-headed but also in the case of light-heavy and light-light when right-headed (\(H\) represents a heavy syllable and \(L\) a light syllable): 7
One of the advantages of assuming this parameter is that we can dispense with such a language-specific rule or condition as H & V propose: the Accent Rule and the stress-bearing condition (12a) and (14a). Specifically, a language that is considered to assume the Accent Rule has either [+ Moraic] or [- Moraic] parameter. Nevertheless, a language typology that assumes the [+ Moraic] parameter cannot be accounted for only by the Accent Rule; therefore, the difference the [+ Moraic] captures must be stipulated in other ways such as (12a) and (14a), but this stipulation is rather awkward.

Finally, we do not assume that, as in certain languages such as Damascene, stress bearer extrametricality is limited to a light syllable and mora extrametricality is limited to the second mora in a syllable. We claim that a heavy and a light syllable have the same status with respect to extrametricality, and so do the first and the second mora. In particular, in a language where both stress bearer and mora extrametricality are assumed, Roca claims that a final superheavy is not counted as extrametrical while a final heavy or light is counted as extrametrical. However, according to our claim, if we apply both stress bearer and mora extrametricality, we predict that a final superheavy or heavy is in fact counted as extrametrical and that in the case of a final light not only the light itself but also the preceding syllable are counted as extrametrical:

(27) Roca's approach Our approach

<table>
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<tr>
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<th>E.M.</th>
<th>Mora Line</th>
<th>E.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stress Bearer Line</td>
<td>E.M.</td>
<td>Stress Bearer Line</td>
<td>E.M.</td>
</tr>
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</table>
As stated below, unlike Roca, we will take a different approach to the Damascene stress, but we make use of this dual extrametricality in accounting for the stress pattern of Palestinian.

To summarize, our system consists of the following rules and parameters:

(28) a. Extrametricality (Mora/Stress Bearer)
   b. [+ Moraic]
   c. H & V's parametric system of Constituent Construction

Given such system, our account of the three dialects' stress facts is straightforward. First, in Cairene extrametricality is applied to the stress bearer except for a word with the final superheavy in which extrametricality is applied to the mora. As for parameters of constituent construction, Cairene has the [+ Moraic] parameter, and its other parameters are the same as H & V's (see (12d-j)):

(29) Cairene
   a. Extrametricality -- Stress Bearer (superheavy: Mora)
   b. [+ Moraic]
   c. Line 0: [+ BND, + HT, left, left to right]
      Line 1: [- BND, right]

(30) a. martaba
      S S S S 
      (#)(#)
      *

   b. Saja ratuhu
      S S S S S
      (#)(#)(#)
      *(#)
      *.

   c. ?adwiya tuhumma
      S S S S
      (#)(#)(#)
      *(#)(#)
      *.

On the other hand, Roca assumes dual extrametricality for Damascene while we claim that the language has only mora extrametricality. For constituent construction parameter, we propose the same parameter settings as H & V (see (14d–j)) although this language has also the parameter [- Moraic]:

(31) Damascene
   a. Extrametricality --- Mora
   b. [- Moraic]
   c. Line 0: [+ BND, + HT, left, right to left]
      Line 1: [- BND, right]

(32) a. darasu
       b. ma daares

Finally, we claim that it is Pleetinian that is an example of the language in which both mora and stress bearer extrametricality must be assumed. Other parameter settings are given in (33) and derivations in (34):

(33) Palestinian
   a. Extrametricality --- Mora and Stress Bearer
   b. [+ Moraic]
   c. Line 0: [+ BND, + HT, left, left to right]
      Line 1: [- BND, right]
3.2 Some Consequences of the Theory

So far, we have been concerned with the Arabic stress and argued that the mora tier and the parameter [± Moraic] plus H & V's parametric theory allow us to account for the stress pattern of the three dialects in a fairly natural way. Furthermore, this system makes possible a natural and ingenious account of the English word stress. As a first step, consider the following three types of words:

(35) a. Cánada  personal  agénda  \textit{(nouns and suffixes with a final short vowel)}

b. k'àngaroó  Tèennessee  ëngineer  \textit{(nouns and suffixes with a final long vowel)}

c. détermine  tèrmént  supréme  \textit{(underived verbs and adjectives)}

To capture the stress pattern of these words, H & V propose an extrametricality with a strict proviso:

(36) \textit{Extrametricality}

\hspace{1cm} * \rightarrow . / \underline{---} \] line 0 in nouns and certain suffixes, provided * dominates a rime with a short vowel (non-branching nucleus) (H & V, p.234)

If we apply it to each of the examples in (35), we get the following results:

(37) a. \textit{Canadà}  \textit{person<àl>}  \textit{agend<à>}

Moreover, English, which is a branching-sensitive language as in the case of Arabic, has the Accent Rule (38) accompanied with a special and clumsy proviso.  (39) is the result of applying this rule to (37):

(38) **Accent Rule**

Assign a line 1 asterisk to a syllable with a branching rime with the proviso that the word-final consonant is not counted in the determination of rime branchingness in the case of the final syllable of underived verbs and adjectives (H & V, p.231).

(39) a.  
```
Canad<ə>  person<əl>  a gend<ə>
```

b. 
```
kan ga roo  Tenn e ss ee  elec tion ee r
```

c. 
```
determine  tor ment  supre me
```

And at last the constituent construction applies to these forms, producing the correct outputs:

(40) **Constituent Construction**

Line 0: [+ BND, + HT, left, right to left]

Line 1: [- BND, + HT, right]

(41) a. 
```
Canad<ə>  person<əl>  a gend<ə>
```

b. 
```
kanga roo  Tenn e ss ee  e lectio neer
```

c. 
```
determine  tor ment  supre me
```

However, our system makes possible a much simpler and more straightforward account of the three types of forms. First, in
nouns and suffixes with a final short vowel extrametricality is on the stress bearer; the parameter settings of the constituent construction are [- Moraic] and the ones in (40):

(42) • Extrametricality —— Stress Bearer
  • [- Moraic]
  • Line 0: [+ BND, + HT, left, right to left]
  Line 1: [- BND, + HT, right]

Second, in nouns and suffixes with a final long vowel, extrametricality applies to the mora line and the parameter settings of the constituent constructions are the same as (42) except for the head-parameter: here, it is right-headed, not left-headed:

(43) • Extrametricality —— Mora
  • [- Moraic]
  • Line 0: [+ BND, + HT, right, right to left]
  Line 1: [- BND, + HT, right]

Third, in underived verbs and adjectives extrametricality and the parameter settings of the constituent construction are much the same as (43), although the head-parameter is left-headed. The difference between (42) and (44) is that extrametricality is on the stress bearer in the former and on the mora in the latter. It should be noted that mora extrametricality neatly captures what the special proviso concomitant with the Accent Rule (38) says:

(44) • Extrametricality —— Mora
  • [- Moraic]
  • Line 0: [+ BND, + HT, left, right to left]
  Line 1: [- BND, + HT, right]
Before concluding this section, a final comment should be added. By introducing the parameter [± Moraic] into H & V’s parametric system, we get a great variety of parameters and their values even if we refer only to the [+ Bounded] parameter. Compare ours with Hayes’s restricted version of the foot construction parameter in (17):

\[
(45) \quad \begin{cases} 
\text{left} & \begin{cases} 
+ \text{UA} & \text{+ Moraic} - - - - - - \text{Moraic Trochee} \\
- \text{UA} & \text{- Moraic} - - - - - - \text{Syllabic Trochee} 
\end{cases} \\
+ \text{BND} & \begin{cases} 
+ \text{UA} & \text{+ Moraic} - - - - \text{Iamb} \\
- \text{UA} & \text{- Moraic} - - - - \text{Iamb} 
\end{cases} 
\end{cases}
\]

We are not yet clear to what extent our rich parametric system should be restricted. In this regard, Hayes suggests an interesting experiment: 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 (46):

\[
(46) \quad \text{Subjective Grouping of Rhythmic Stimuli}
\]

a. Even duration: \[\ldots \; \cdot \; \cdot \; \cdot \; \cdot \; \cdot \; \cdot \; \cdot \; \cdot \; \ldots \]
\[\ldots [\cdot \; \cdot \; \cdot ] [\cdot \; \cdot \; \cdot ] [\cdot \; \cdot \; \cdot ] [\cdot \; \cdot \; \cdot ] \ldots \]

b. Uneven duration: \[\ldots \; \cdot \; \cdot \; \cdot \; \cdot \; \cdot \; \cdot \; \cdot \; \cdot \; \ldots \]
\[\ldots [\cdot \; \cdot \; \cdot ] [\cdot \; \cdot \; \cdot ] [\cdot \; \cdot \; \cdot ] [\cdot \; \cdot \; \cdot ] \ldots \]

(Hayes (1987, p.287), cited from Woodrow (1951))

This experiment demonstrates, he claims, that there is a general law called law of iambic and trochaic rhythm: iambic rhythm inherently involves uneven duration with longer, more prominent elements last whereas trochaic rhythm involves even duration. Now he
concludes that the foot construction algorithms in (17) (repeated here in (47)) are designed to satisfy the law of iambic and trochaic rhythm: 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 feet whose syllables are phonologically equal in duration:

(47) a. Syllabic Trochee \[ \text{\scalebox{1.1}{$ \ast \quad \ast$}} \]; else \( \_ \_ \)

Moraic Trochee \[ \text{\scalebox{1.1}{$ \ast \quad \ast$}} \) or \( \text{\scalebox{1.1}{$ \ast \quad \ast$}} \); else \( \_ \_ \)

b. Iamb \[ \text{\scalebox{1.1}{$ \_ \quad \ast$}} \]; else \( \_ \_ \) or \( \_ \_ \)

If what he claims is true, we may restrict our rich parametric system just in the proper way.

4. Conclusion

We have thus far argued that Roca's split tier between mora and stress bearer and our \[ \pm \text{Moraic} \] parameter allow us to dispense with the Accent Rule (12c) and (14c) and the stress-bearing condition (12a) and (14a) and, as a result, to capture the stress facts of the three Arabic dialects neatly and naturally. Moreover, given such system, we can provide a simple and straightforward account of English stress, for we can dispense with clumsy and awkward provisos concomitant with its extrametricality (36) and Accent Rule (38). And yet our rich parametric theory may be much more constrained in some way if Hayes's suggestive words are to the point.

Footnotes

* This paper is a slightly revised version of Tanaka (1988), a paper read at the fourth meeting of the Tsukuba Circle of Phonologists. I would like to thank Shosuke Haraguchi, Norio Yamada, Masao Okazaki, and Takeru Honma for their valuable comments and suggestions on the earlier one. In particular, Okazaki and Honma sincerely and carefully review and discuss the topic in various points of view. All remaining errors and inadequacies are my own
responsibility.

H & V, Hayes, and Tanaka represent metrical constituents in a different way from one another although they all use "bracketed grids" (see section 1.2.). The conception of metrical constituent also varies among them; namely, in H & V they are derived by parameters [± BND], [± HT], and [Left/Right] while in Hayes and Tanaka they are given a priori, not derived by rule, at least at the foot level and the type of metrical constituent itself is parametrized. For discussions of the preference of the latter conception over the former, see Hayes (1987) and Tanaka (1989; in progress)).

Here and below, we follow Hayes in representing a heavy syllable (CVC or CVV) as - and a light (CV) as -.

Tanaka (1989; in progress) proposes and argues the restriction of applying extrametricality to prosodic categories: mora, syllable, foot, etc. In this respect it is not surprising that a foot may be invisible to main stress assignment although there are few cases in which a foot counts as extrametrical. In section 3 we follow Roca in allowing mora to be extrametrical and present several cases where stress facts can be accounted for ingeniously by doing so, and various arguments for mora as a prosodic category are given in the works given above.

In addition to stress, some arguments are adduced for "mora tier" or "weight tier" in recent works such as Hyman (1985), Hock (1986), and Hayes (1989). In Hayes, the skeletal position (i.e. X-tier), which is now assumed extensively among most phonologists, is displaced with what is equivalent to the mora tier here with respect to compensatory lengthening. This is just the Hyman's conception although he use it to invoke other phenomena. In Hock, not only the CV tier in the sense of Clements and Keyser (1983) but what we call the mora tier are required to describe various types of compensatory lengthening. As for other segmental facts, vowel deletion in Old English may well be said to support the mora tier, which deletes high vowels after a heavy syllable or two light syllables (here, details are ignored for expository purposes). For example, high vowel deletion in démían and wénodu is accounted
for as below (I would like to thank M. Okazaki for pointing out the data to me):

\[
\begin{align*}
\text{i) a. } & \text{de } \text{mi } \text{an} & \text{b. \text{wero } \text{du}} \\
& \text{Mora Tier} & \text{Mora Tier} \\
& \text{Line 0} & \text{Line 1} \\
& \text{ii) High Vowel Deletion} & \text{Melody Tier} \\
V [+ \text{high}] & \rightarrow \phi & \\
& \text{Mora Tier} & \\
& \text{Line 0} \\
& \text{Line 1} & \\
\end{align*}
\]

If we do not have the mora tier, we cannot define the environment where a heavy syllable is equated with two lights and so do not account for the way of deletion (for further details and arguments, see Tanaka (in progress)).

\(^5\) H & V seem to assume implicitly two functions of line 0 asterisks. One is what functions as "weight-bearing" units as in the case of Cairene while the other is what functions as stress-bearing units as in the case of vast varieties of languages they examine. If we were required to allow line 0 elements to have these two functions, we would have find a language in which all rime phonemes are aligned with line 0 asterisks and the parameter settings for foot construction are [+ BND, + HT, right]:

\[
\begin{align*}
\text{iii) a. } & \text{CVV} & \text{b. } \text{CVC} & \text{c. } \text{otherwise CVV CV} \\
& \text{Mora Tier} & \text{Mora Tier} & \text{Mora Tier} \\
& \text{Line 0} & \text{Line 0} & \text{Line 1} \\
& \text{CVV CV} & \text{CV C V} & \\
\end{align*}
\]

The reasoning implicit here is that just as stress-bearing languages have the headedness parameter left/right symmetrically, weight-bearing languages must have right-headed feet as well as left-headed ones in Cairene. However, we are not clear whether such a language would exist. One possibility is the case of Lithuanian, where both (a-b) above and (a'-b') below seem to be needed:

\[
\begin{align*}
\text{iv) a'. } & \text{CVV} & \text{b'. } \text{CV C} \\
& \text{Mora Tier} & \text{Mora Tier} \\
& \text{Line 0} & \text{Line 1} \\
& \text{CVV CV} & \text{CV C V} & \\
\end{align*}
\]

Lithuanian do not have right-headed feet uniformly (and, moreover, words that include (a-b) type syllables are remarkably marked and supplied right-dominant feet underlyingly), so we do not believe
at present that we should allow line 0 asterisks to involve two functions — stress-bearing and weight-bearing — only for Cairene and Lithuanian.

Other arguments for doing without the Accent rule are roughly four-fold. First, an analysis using the Accent Rule suffers from data gap; that is, in H & V's system eight types of feet are derived by combination of their parameter settings, but some are not found in natural languages (here, only [+ BND, + HT] languages are referred to):

\[
\begin{align*}
\text{v) } & \quad \text{weight-bearing Cairene?} \\
\text{left} & \quad \begin{cases} 
\text{with AR} & \text{stress-bearing *} \\
\text{without AR} & \text{weight-bearing *} 
\end{cases} \\
\text{+ BND — + HT} & \quad \begin{cases} 
\text{weight-bearing *} \\
\text{stress-bearing *} 
\end{cases} \\
\text{right} & \quad \begin{cases} 
\text{with AR} & \text{weight-bearing Lithuanian?} \\
\text{without AR} & \text{stress-bearing} 
\end{cases}
\end{align*}
\]

Asterisks indicate the foot types no language makes use of: the remaining feet are [+ BND, + HT, left/right, without AR, stress-bearing], and these two are sufficient to account for stress facts of various kinds of languages given the parameter [± Moraic]. But our system may need further restriction as stated in (45) below (gaps in H & V are six (or four if '?s are ignored) while ours are three). For further discussions of data gaps, see Hayes (1987) and Tanaka (1989; in progress). Second, as pointed out in section 3.2, if we were to assume the Accent Rule, it should be accompanied with a special and clumsy proviso in (38), which is imposed only on underived verbs and adjectives. We will show there that our mechanism does not have such a stipulative proviso and yet provides a more explanatory account even if the Accent Rule is not posited. See also footnote 8. Third, in Yidin' and Pirahã two metrical planes (i.e. two types of metrical constituent) are required to account for their stress patterns: in our system the information the Accent Rule would have is encoded in the mechanism itself, not realized as a language-particular rule, so that such a
division of metrical planes is not appealed to. In other words, the stress pattern found in these languages is best explained by making use of the information the Accent Rule would have, but not by the Accent Rule itself nor two metrical planes (I would like to thank M. Okazaki for suggesting this point to me). Finally, in languages such as English, Seneca, and Spanish, line 1 asterisks and metrical constituents assigned by earlier application of the Accent Rule and the cyclic stress rule respectively are erased by Stress Conflation, and then noncyclic stress rule re applies to mark the position of secondary stresses: if the Accent Rule is not posited, we need not erase the metrical constituents assigned earlier and reassign new metrical constituents, so need not assume the Stress Conflation and the noncyclic stress rule for these languages (the function of the Stress Conflation and the noncyclic stress rule is to erase and adjust the elements (i.e. secondary stress) misassigned by the Accent Rule. In fact, in Tanaka (in progress), arguments against the Stress Conflation and the noncyclic stress rule are adduced by examining various types of languages, and the power of these two rules is much more restricted.

In Tanaka (1989; in progress) a somewhat different approach is proposed without appealing to the parameter [± Moraic], which can do the same descriptive work and yet has more simple and restrictive mechanisms.

H & V suggest a possible alternative without such a proviso. According to them, constituent-final consonants may be syllabified by a rule that is assigned to the non-cyclic stratum, whereas other portions of the phoneme string are syllabified by rules ordered at the beginning of the cyclic stratum. Consequently, word-final consonants do not count in determining rime branchingness. However, this analysis is very tentative and lacks a principled account. If the special behavior of word-final consonants with respect to syllabification is found elsewhere, H & V's account is not hopeless. For example, word-final coronals do not participate in syllabification and do not trigger shortening as in pint, flounce, or beast (see Myers (1987); for idiosyncrasies of word-final coronals, see Kiparsky (1981) and Selkirk (1982)), but this speciality does
not hold for underived verbs and adjectives since they do not always end in coronals as in *supreme, usurp, or follow.*

In fact it is not surprising that the headship parameter for the class of these words is [right] and the one for the class of others is [left]: the same language may select both values of the parameter, whichever is determined according to the phonological or morphological class the words belong to. First, phonologically, the words in (43) all have a branching nucleus (i.e. a long vowel) in the ultimate syllable. This property is sufficiently remarkable to determine the class they belong to, and the same reasoning also holds for certain classes of words in Yidin'. Yidin' words are distinguished between those that contain an even-numbered syllable with a long vowel and those that do not. Stress falls on even-numbered syllables in the former case and on odd-numbered syllables in the latter:

\[
\begin{align*}
\text{vi) a. } & \text{gudá:ga 'dog(abs.)'} & \text{b. } & \text{gúdágágu 'dog(purp.)'} \\
& \text{wawá:dinú 'see(antipass.)'} & & \text{wáwal 'see(inf.)'}
\end{align*}
\]

According to McCarthy and Prince (1986), the class of words in (a) contains iambic feet whereas the one in (b) contains trochaic feet. Moreover, Yidin' has the parametric value (b) of the following principle (McCarthy and Prince (1986, p.10)):

\[
\text{vii) Uniformity Parameter}
\]

A language may require that all feet have the same labeling (a) everywhere; (b) within the word.

Here, "within the word" reads "within a certain class of words". Consequently, we can assume that English also has the (b) value. Second, morphologically, the type of words grouped in (43) may contain certain suffixes such as *-ee* (appointee, employee), *-eer* (electioneer, pamphleteer), and *-aire* (questionaire, millionaire). The very fact that they have certain types of suffixes is remarkable enough to be assumed that they belong to a certain class, although the class may also have monomorphemic words such as *-oo* (kangaroo, taboo, tattoo, bamboo), *-ee* (Tennessee). These words
are determined underlyingly as belonging to that class.

10 In (46a) all r's have even duration of beeps while in (46b) longer duration of beeps is depicted as - and shorter duration as -. In a phonological context, phonetic duration in question is to be interpreted as syllable quantity (i.e. the quantity opposition of heavy vs. light syllable may form a phonological categorization of a temporal difference), so that the way of grouping or bracketing is directly captured and represented in his foot typology, as stated below.

References


Doctoral Program in Literature and Linguistics
University of Tsukuba