# Word Stress and Syllable Structure in English*

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0. Introduction

Most phonologists regard the syllable as a linguistically significant unit which must have its place in phonological theory. However, the interpretation of syllable constitution varies with different approaches to the syllable. In this paper, I presuppose that the syllable has a hierarchically organized internal structure. More specifically, with Selkirk (1980a), I postulate that the syllable (σ) has two major constituents--the onset (O) and the rime (R)--and the rime itself divides into the peak (P) and the coda (C) as shown in (1):

(1)
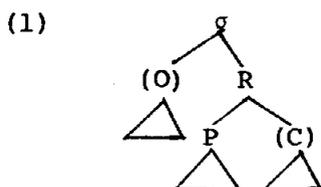
In what follows, I will be concerned with stating the characteristics of the syllable more definitely; and then, on the basis of syllable internal branchingness, I will examine English word stress and propose a new analysis which accounts for data which were considered exceptional in previous analyses.

1. English Syllable Structure

A grammar must provide for some statement of the notion 'possible syllable' of a language. This can be executed in the form of a template with feature specification. The syllable template for English would be as follows:[1]

(2)   *The English Syllable Template*
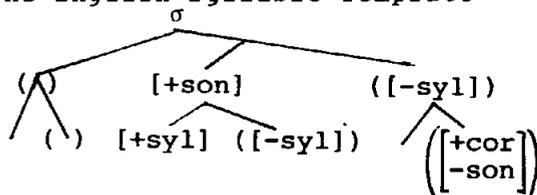
(where features which are irrelevant to the present discussion are omitted.)

Applying this template to *flounce, fly, flat,* we will represent their syllable structures as follows:

(3)   *flounce*   *fly*   *flat*
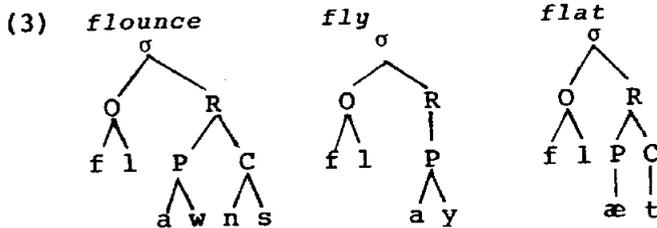
Observing these examples, we may say that the branching peak is associated with a diphthong. However, the peak may branch even in a syllable with a simple vowel.

Let us first examine such words as *tinct, prompt, exerpt, mulct* which contain three consonants after a simple vowel. Applying the Syllable Template to a representative *tinct,* we can represent it as in (4):

(4)
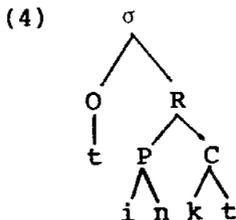
Notice that the peak branches though the vowel itself is simple.

Furthermore, in syllables consisting of a two consonant cluster after a simple vowel, e.g., *solve, silk, limp, camp,* the peak may branch, for the second element of the coda must be coronal (see Selkirk (1982)). In the case of *solve,* for example, the final /v/ is non-coronal, so it must be associated with the first slot of the coda and not the second one as illustrated below; as a result the peak necessarily branches.

(5)
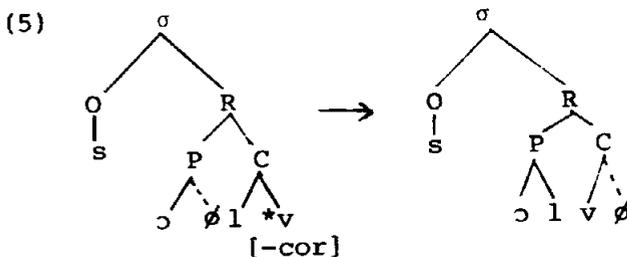
From these observations, we can say that not only glides but also nasals and liquids may be associated with the second slot of the peak. This statement is not unreasonable because glides, liquids and nasals are all nonsyllabic sonorants and constitute a natural class; further, they function in the same way in such phonological processes as *t*-flapping. It is usually observed that /t/ is characteristically voiced in American English when preceded and followed by a vowel, the following vowel being unstressed; and a glide may intervene between /t/ and the leftward vowel: *bútter, cíty, lóiter, dóubting*. However, *t*-flapping can be observed also in such words as *fórty, wínter, málted* in which a liquid or a nasal intervenes between /t/ and the preceding vowel (cf. Selkirk (1972), Kahn (1976)). I think this shows that liquids and nasals have the same segmental property as glides.

Summarizing, we have shown that glides, nasals and liquids <u>may</u> be the second element of the peak.

Having this point of view, we will be faced with another question. In such words as *pan, pal* whose rime consists of a simple vowel and a liquid or nasal, theoretically there are two possible associations; that is, the liquid or nasal may be associated with either the peak or the coda as in (6):

(6)
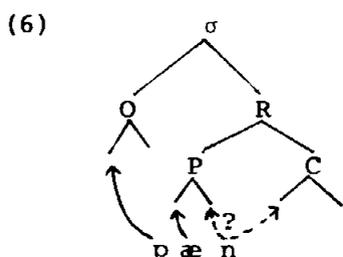
I turn now to discussion of this matter. If /n/ in (6) is associated with the peak, the peak branches, but if it is associated with the coda, the peak does not branch. As mentioned in introduction, we will discuss stress rules in terms of branching syllable structure, so we cannot leave this problem unsolved.

Relating to this problem, recall the principle of 'Proper Inclusion Precedence' proposed for the relative order of application of rules in Koutsoudas *et al.* (1974):

(7) *Proper Inclusion Precedence*

For any representation R, which meets the structural descriptions of each of two rules A and B, A takes applicational precedence over B with respect to R if and only if the structural description of A properly includes the structural description of B.

This principle does not directly specify the association relation between segments and syllable internal nodes, but it is possible to regard the association as a kind of rule. Therefore it would not be unreasonable to consider the precedence of one association of the two possible associations over the other as a case of the application of this principle. The two possible associations can be represented as in (8) where (i) represents the feature matrix for the second slot of the peak and (ii) for the first slot of the coda:

(8) (i) P (ii) C

$$\left[\begin{array}{c}+son \\ -syl\end{array}\right] \qquad [-syl]$$

$$\left\{\begin{array}{c}nasal \\ liquid\end{array}\right\}$$
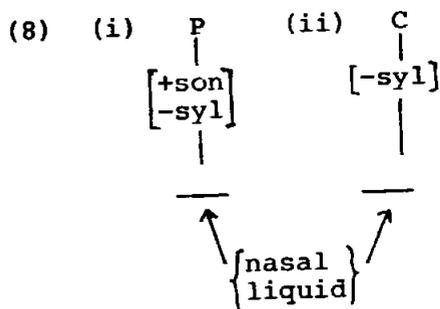
In this case, we can say that $\left[\begin{array}{c}+son \\ -syl\end{array}\right]$ properly includes [-syl]. Hence the association in (8i) takes precedence over that in (8ii).

To sum up, nasals and liquids as well as glides should be a second member of the peak preferentially; though they are obliged to be a member of the coda in the case where the two slots of the peak are already associated with a diphthong as in P C .

/flawns/

So far we have investigated syllable internal structure. We must now briefly mention syllabification, the assignment of each syllable structure to the sequence of segments. I claim following McCarthy (1979) that it takes place in underlying representations or at the beginning of phonological cycle and resyllabification occurs automatically if needed.

2. The English Stress Rule

2.0. Preliminaries

In studies which pay attention to syllable weight, it has been often pointed out that 'heavy' syllables $(C_0 \breve{V} C_1, C_0 \bar{V})$ are more stressable than 'light' ones $(C_0 \breve{V})$. Such a generalization by itself, however, cannot explain the stressing of the second syllable of the examples in (9), where the underlined heavy syllable is stressless and the first light syllable is stressed instead.

(9) désignàte, ánecdòte, récognìze

Consequently, it is not enough to discuss stress assignment only on the basis of the distinction between heavy and light syllables. In this section let us reexamine stress placement from a different viewpoint from the light-heavy distinction.

2.1. Peak-branching, Coda-branching and Stress

First consider the words in (10):

(10) a. patról, remóte, extréme, eráse, applý, húrricàne
     b. aróma, Àrizóna, Mìnesóta, Àpalàchicóla

These words contain a tense vowel in the underlined syllable, so in the standard theory represented by Chomsky and Halle (1968) (*SPE*) the stress contours of these words are explained in terms of the tenseness of vowels. In our theory, a syllable with a tense vowel can be represented as a peak-branching syllable. That is, we can say that in the examples of (10a) the peak of the stressed final syllable branches and in those of (10b) the peak of the stressed penultimate syllable branches.

Next, consider the following examples which contain no tense vowel:

(11) veránda, agénda, góndola, álgebra, Lacérta, Colúmbus

Though the vowels in the underlined syllables are lax, it is to be noted that the consonants following the vowels in question are syllable-final nasals or liquids, so, as argued above, in these examples the stressed syllable contains a branching peak. Accord-

ingly, we can tentatively formulate the stress assignment rule as (12):

(12) Stress any syllable if its peak branches

As typical examples assigned stress by rule (12), we can give Tìcònderóga, Pàndóra:[2]

(13)

$$
\begin{array}{ccccc}
\text{P} & \text{P} & \text{P} & \text{P} & \text{P} \\
\wedge & \wedge & | & \wedge & | \\
\text{t a y k} & \text{ɔ n d} & \text{V r} & \text{ó w g} & \text{V} \\
+ & + & - & + & -
\end{array}
\qquad
\begin{array}{ccc}
\text{P} & \text{P} & \text{P} \\
\wedge & \wedge & | \\
\text{p æ n d} & \text{o w r} & \text{V} \\
+ & + & -
\end{array}
$$

The symbols '+' and '-' will be used in order to represent a stressed and an unstressed syllable respectively. In these examples, both the first and second syllables are stressed, and from the viewpoint of rhythm, this is not favorable. But, conversly, this proves the strong tendency that the peak-branching syllable receives stress.

Note, in addition, that in the present analysis we can appropriately explain the fact that the second syllable of the words in (9) does not receive stress, for the peak of the syllable in question does not branch.

Moreover, in this analysis we can correctly assign stress to such words as Japán, Brasíl, canál, too, which are generally regarded as exceptional examples with foreign accent.

Traditionally C_0V-sonorant consonant clusters and C_0V-nonsonorant consonant clusters have been categorized as the same category 'heavy syllable'. However, contrary to the former, the latter seldom receives stress (cf. (9)). This is because, I think, glides, liquids and nasals are more sonorous than the other consonants (i.e., obstruents), therefore the degree of total sonority of the rime formed with a vowel and a sonorant is greater than that of the rime formed with a vowel and a obstruent; and sonority is an important factor constituting stress.

Besides the relation between peak-branching and stress, there exists another notable fact. A syllable with the complex rime VCC is more apt to receive stress than that with the less complex rime VC. Notice the stressed second syllable in the following examples:

(14) íncèst, bequést, bómbàst, diréct, corrúpt, dérelìct

The sequence of two consonants in question can be regarded in our terms as a branching coda, so we can formulate the following rule to capture this generalization:

(15) Stress any syllable if its coda branches

Collapsing rule (15) with rule (12), we can formalize the following rule in the familiar notation:

(16) *The Syllable-based English Stress Rule*

$$\sigma \rightarrow \underset{+}{\sigma} \, / \, \ldots \underline{\hspace{1cm}} \ldots$$

R

α   (α = peak, coda)

This rule may apply at any position in words where the structural description is met and its application is not directional, so does not require the representation of a starting point We can correctly assign stresses to the first, second and fourth syllables of *Tìcònderóga,* for example, applying rule (16) left to right or right to left. Furthermore, I believe that we need not assume any language-particular rule other than rule (16) for word stress assignment in English. Other required stresses can be determined by the universal principle and rule discussed below.[3]

2.2. The Rhythmic Alternation Principle and Stress Supplementation

Since we concluded that the word stress assignment rule for English is only rule (16) (hereafter ESR), we must here supply the devices to assign stress to the syllables which do not have a branching peak or coda. To begin with, let us examine the underlined syllables in the following examples taken from (9) and (10b):

(17) désignàte, ánecdòte, récognìze, Àrizóna, Mìnesóta, Àpalàchicóla

In previous studies, the syllables in question are assigned stress

by a kind of English stress rule called the Alternating Stress
Rule or the Stress Retraction Rule. However, patterns of alter-
nating stress across the word are not particular to English, and
I assume that there exists a universal rhythmic ideal that favors
a strict alternation of strong and weak beats. Let us call this
principle the Rhythmic Alternation Principle (RAP) (cf. Selkirk
(1984)). Then, it would be plausible to suppose that the stresses
in question are assinged by a universal stress assignment rule
so as not to violate this principle. I name the rule Stress
Supplementation (SS).

Relating to this universal rule, note that there is an impor-
tant parameter of directionality. As far as the examples in (17)
are concerned, we see that SS applies right to left in English.
In order to verify this, let us examine *hèrmáphrodìte* as an exam-
ple:

(18)

$$\text{hermaphrodite} \xrightarrow{\text{ESR}} \begin{array}{c}\text{hermaphrodite}\\ + \qquad +\end{array} \xrightarrow{\text{RAP}} \begin{cases} \begin{array}{c} \text{*hermaphrodite}\\ +\frown\rightarrow+\ + \end{array} \quad \text{SS (L}\rightarrow\text{R)} \\[2em] \begin{array}{c} \text{hermaphrodite}\\ +\ \ +\frown+ \end{array} \quad \text{SS (R}\rightarrow\text{L)} \end{cases}$$
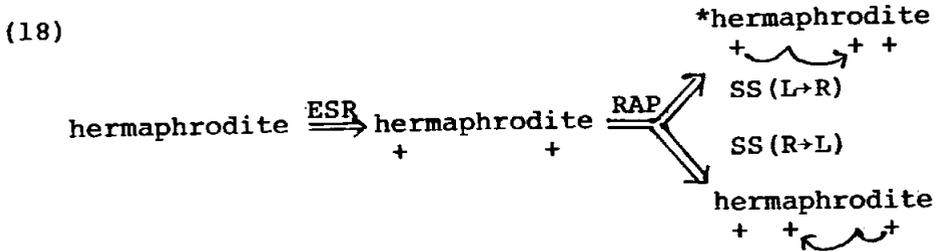
Since the peak of the initial and final syllable branches, stresses
are assigned there by the ESR. But there remain two unstressed
syllables word-internally, and this result violates the RAP, so
SS must be invoked.[4]

Note that if we regard the initial syllable as the starting
point of SS application, we assign stress to *hermaphrodite* in-
correctly. The correct stress contour of *hermaphrodite* tells us
that SS applies in English right to left and the starting point
of SS application is the rightmost stressed syllable.[5]

Consider, next, words of the type *América* which include no
peak-branching syllables, so cannot be assigned any stress by the
ESR:

(19) aspáragus, génesis, cámera, hìppopótamus

If these words received no stress, the result, of course, would violate the RAP. Therefore, SS must be invoked also in this case. These words have stress on the antepenultimate syllable; but regarding the last syllable as the extrametrical with Hayes (1980, 1982), the stressed syllable is, in effect, penultimate. Now the parallelism on stress placement between these examples and those in (17) emerges. That is, in the examples in (17) the ESR assigns stress to the last or the penultimate syllable and SS places stress on every second syllable before it; in those of (19), the starting point of SS is the end of word, and as the last syllable is extrametrical we can say that SS stresses the second syllables away from the end. Taking these into account, we can formulate SS with parameters set for English as follows:

(20) *Stress Supplementation*

$$\underset{-}{\sigma} \rightarrow \underset{+}{\sigma} / \underline{\qquad} \underset{-}{\sigma} \begin{Bmatrix} \sigma \\ + \\ \square \end{Bmatrix}$$

In sum, so far we have argued that syllabification occurs according to the Syllable Template before the application of stress assignment rules; and if output stress contours violate the RAP after the application of a language-particular stress rule, SS is invoked.

Incidentally, as I mentioned Extrametricality above, I briefly discuss it here. Hayes proposed in his convincing articles three kinds of extrametricality for English, namely, Noun Extrametricality (NE), Adjective Extrametricality (AE) and Consonant Extrametricality (CE). As to the necessity of NE and AE I have no objection. But note that in the present analysis we can dispense with CE. As examples to which CE is applied, Hayes presents such words as *astónish, devélop*. Hayes assigns stress to (or, more precisely, constructs a foot on) the syllable whose rime branches. Thus, the last syllable of *astonish, develop* would receive a stress in his analysis because its rime branches, To avoid this, CE is needed. Our ESR, however, is not based on the branchingness of the rime, so it does not assign a stress to the

last syllable of the words in question. Correct stress is assigned
to the penultimate by SS. Consequently, we have no need of CE.

Finally, before proceeding to the next section, let us clari-
fy the process of stress assignment to derivatives. Taking *èxpèc-
tátion* as an example, I assume the following derivation (where
syllable structure assignment is omitted):[6]

(21)   [[ekspekt]ey(tyVn]]

–	+			rule (15)
+	–	+	ϕ	NE, rule (12), SS
+	+	+	–	output

First, in the inner cycle, the ESR assigns stress to the second
syllable which is coda-branching. Next, in the outer cycle, re-
syllabification takes place, so the second syllable does not re-
ceive stress and the third and initial syllables are assigned
stress by the ESR and SS respectively. And finally the stresses
assigned in both cycles are brought together as the output. That
is to say, if a syllable receives stress in any cycle, then it will
appear as a stressed syllable in the output.[7]

3. Destressing
3.0. Preliminaries

As a result of the application of the ESR, stress contiguity
may arise, so extra stresses must be eliminated by destressing
rules in order to achieve eurhythmicity. There would be three or
four types of rules of destressing, but, for the lack of space,
I will discuss only one of them, the Medial Destressing Rule (MDR);
and show that our analysis, in which nasals and liquids can be
the second member of the peak, can account for destressing pat-
terns which were exceptional to the previous analyses.[8]

3.1. Medial Destressing

Concerning the MDR, let us examine the following nouns:

(22) a. èxplanátion (expláin)   còmbinátion (combíne)
         còmposítion (compóse)   ìnvitátion (invíte)

b. èxpèctátion (expéct) rèlàxátion (reláx)

c. ìnformátion (infórm) trànsformátion (trànsfórm)

cònsultátion (consúlt) làmentátion (lamént)

These examples should all be regarded as nominals derived from the corresponding verbs given in parentheses. So in the first cycle, all receive a stress on the second syllable. However, the second syllable of the words in (22a) and (22c) becomes stressless, whereas that of the words in (22b) remains stressed. In *SPE*, it was pointed out that a vowel becomes unstressed if it is followed by no more than one consonant followed by a primary-stressed vowel, while it otherwise remains stressed. This formulation can account for the stress patterns of words in (22a) and (22b), but it incorrectly predicts that the words in (22c) should show the same stress pattern as those of (22b) because there exist two consonants between the second and the third vowels. Because of this, words like those of (22c) were considered to be exceptional, i.e., non-derived nominals.

Relating to medial destressing, in Kiparsky (1979) where the hypothesis that metrical structure assignment is cyclic is proposed, for *expectation*, for example, the following derivation is assumed:

(23)
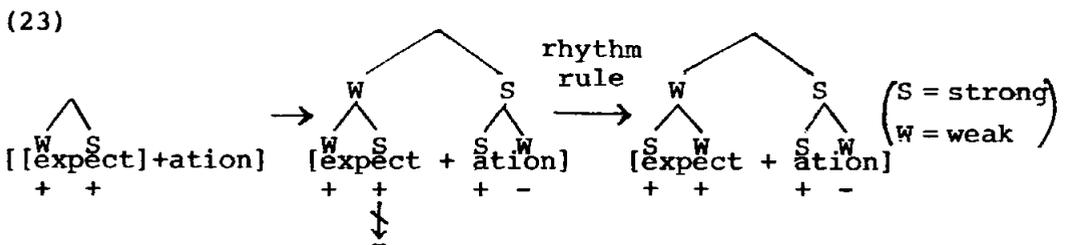
The second syllable is labeled *s* in the first cycle, and it blocks destressing because of the general metrical condition that a metrically strong node cannot be associated with a stressless syllable. However, we should note that his analysis includes a serious problem; that is, according to Kiparsky's framework, *s* must be assigned also to the second syllable of words like those listed in (22a) and (22c), blocking destressing. This poses a question about the validity of an approach which assigns metrical structure

in earlier cylces and respects it. I therefore assume that the
prosodic structures superordinate to the syllable are assigned
non-cyclically after the application of stress assignment rules
and destressing rules (cf. (26)).

Contrary to Kiparsky's analysis, the recent grid-based anal-
ysis of Selkirk (1984) can account for the absence of stress on
the medial syllable of such words as *explanation, information*.
But, unfortunately, in her analysis words of the *expectation* type
are regarded as exceptions.

In our view, however, none of the cases shown in (22) are
ever exceptional and their stress contours can be explained by
the MDR based on the syllable internal branching condition. Tak-
ing *explanation, expectation* and *information* as representatives
from (22a), (22b) and (22c) respectively, let us assign syllable
structure to the second syllable of each word:

(24) a.   b.   c.

$$
\begin{array}{ccc}
\overset{\displaystyle\wedge}{\underset{\substack{O\ P\\ \triangle\ \triangle}}{\overset{R}{|}}} & \overset{\displaystyle\wedge}{\underset{\substack{O\ PC\\ \triangle\ |\ |}}{\overset{R}{\wedge}}} & \overset{\displaystyle\wedge}{\underset{\substack{O\ P\\ |\ \triangle}}{\overset{R}{|}}}
\end{array}
$$

ek-spley-ney-tyVn   ek-spek-tey-tyVn   in-fɔr-mey-tyVn

Notice that resyllabification takes place and *n, t, m*, which are
associated with the coda in the embedded words, are resyllabified
as the onset of the following syllable. As a clear difference
among these examples, we find that the second syllable's rime branches
in (24b) but not in (24a) and (24c), and only in the latter case
does destressing occur. Thus we can state that if three stressed
syllables are adjacent and the medial syllable's rime does not
branch, then the medial syllable becomes stressless.[9] Formally,
we have the following rule:

(25)   *The MDR*

$$
\underset{+}{\sigma} \rightarrow \underset{-}{\sigma} \ / \ \underset{+}{\sigma} \underset{\substack{|\\ R\\ |}}{\rule{0pt}{0pt}} \underset{+}{\sigma}
$$

This rule is also involved in the medial destressing of words such
as ámpersànd, mérchandìse, cóncentràte, ínventòry, mómentàry,
áuthentícity.

The result is that, for medial destressing, the <u>number</u> of
consonants intervening between vowels is no matter. It is only
important whether the syllable in question has the coda, which
plays the role of a fender to stress clashes. Whether the syllable
in question is dominated by *s* or *w* is not necessary information
for medial destressing.

Finally, taking *information* as an example, we will give its
whole derivation as follows:

(26)   1st cycle

syllabification
ESR
$\Longrightarrow$ [[infɔrm]eytyVn]

2nd cycle

resyllabification
NE, ESR
$\Longrightarrow$ [infɔrmeytyVn]

output of the cyclic rules   [infɔrmeytyVn]

MDR $\Longrightarrow$ infɔrmeytyVn

prosodic structure assignment $\Longrightarrow$ [information]

4. Conclusion

In this paper, we have discussed word stress pattern in terms of syllable internal structure which is presumed to be organized hierarchically, and we have shown that the possibility of stressing words seems to involve the properties of the peak, the coda and the rime constituent of the syllable (not those of the onset). Moreover, departing from the rule-based analysis we have taken a principle and parameter-based orientation. As a result, the exceptions to previous works have become explainable. I hope that all of the advantages of our analysis make a contribution to the theory of stress rules.

NOTES

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[1] As is well known, in English, ternary consonant clusters in the syllable initial and final positions are permitted as in *street, next* when /s/ is included as an obligatory member. But here I ignore such cases as special cases, and present only the binary branching onset and coda template.

As for feature specification, it is controversial whether we should adopt the feature [±syllabic]. Kaye and Lowenstamm (1981) argue that this feature does not play a role in the grammar. An instance making no use of this feature is the version in Selkirk (1980b), where, for example, the first slot of the peak is specified as $\begin{bmatrix} +son \\ +vocalic \end{bmatrix}$. But notice that nasals which are non-vocalic may be the first element of the peak when they become syllabic as in *prizm*. Therefore, it seems to me that

making use of [±syllabic] is more plausible (cf. Halle (1978)).

[2] I put aside discussion on the level of stress. Note that I am discussing here only the position of stress. As to the level of stress and metrical structure assignment related to it, I will discuss them in the following section.

[3] As one additional stress rule we might need to propose the initial stress rule which assigns stress to the first syllable of such words as *ràtoón, Èstónia,* for the peak or the coda of the first syllable does not branch, and rule (16) does not assign stress there. However, if we proposed such a rule, it would assign stress to the first syllable of such words as *América, horízon,* too. Then we must further propose a destressing rule to apply only to the first syllable of the latter; but I cannot find the crucial distinction between the former and the latter. So I will leave the problem of initial syllable stressing open.

[4] In such words a *Tàtamagóuchi, Wìnnepesáukee,* in fact, a sequence of two unstressed syllables can be found, but this type of stress pattern is non-basic (cf. Hayes (1980)), so we will ignore such examples here.

[5] In Maranungku, for example, in contrast with English, SS applies from left to right (cf. Halle and Clements (1983)).

[6] Φ means that the syllable is unspecified for stress, for the syllable is extrametrical and ignored by stress assignment rules. And Φ is later converted to '-' by convention, I assume.

[7] For further dicussion of the phonological cycle and relevant facts, see Ohta (1984).

[8] For the other destressing rules, see Ohta (1984).

[9] As apparent counterexamples to this analysis, there are words like *àttèstátion.* In Kahn's analysis, *attestation* should be syllabified as a-tte-sta-tion, i.e., the rime of the second syllable does not branch. Then the MDR would apply, contrary to fact. However, *attestation* appears to be syllabified as a-ttes-ta-tion (cf. Davidsen-Nielsen (1974)). Then it is natural that it shows the same stress pattern as that of *expectation.*

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