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A New Account of Subsidiary Stresses in English Words*

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ABSTRACT. This paper puts forward in brief a new account of the subsidiary stress assignment of words in American English. It is assumed that the subsidiary stress rule of American English is composed of 16 *Positional Functions*, postulated in Yamada (2010). For each word, a number of Positional Functions are activated according to their specified conditions for application. Each Positional Function gives its designated stress value to the specified syllable position. Subsidiary stress assignment is thus reduced to an interaction of these closely related universal Positional Functions.

Keywords: English words, subsidiary stress, Positional Functions

1. Introduction

The purpose of this paper is to briefly outline a new theory, called Positional Function Theory, put forward in Yamada (2010), which differs from current Optimality Theory (hereafter abbreviated as OT) and Metrical Theory (henceforth MT).

Stress has been studied in phonology for many years, and remains one of the most important research topics of the field. Many proposals have been put forward to account for the mechanism of primary stress assignment of words in English, as shown in (1a):

(1) a. Primary Stress Assignment: Chomsky and Halle (1968), Liberman and Prince (1977), Hayes (1980), Halle and Vergnaud (1987), Halle and Kenstowicz (1991), Idsardi (1992), Burzio (1994), Hammond (1999), Pater (2000), etc.
b. Subsidiary Stress Assignment: Halle and Vergnaud (1987), Pater (2000)

We can state that these studies dealing with primary stress assignment have been successful by and large, compared with the fewer and less successful accounts of English subsidiary stress assignment, shown in (1b).[1] The reasons for this small number and relative lack of success of accounts of subsidiary stress assignment lie (a) in the complexity of the subsidiary stress assignment mechanism and (b) in elusive subsidiary stress data.

2. Problems

2.1. OT and MT

To highlight these points, let us briefly compare two representative accounts: one from OT, the other from MT, using the examples in (2):

(2) a. *àdvàntágeous* (< *advántage*) *còndèmnátion* (< *condémn*)
còndènsátion (< *condénse*) *ìmpòrtátion* (< *impórt*)
b. *còn<u>fir</u>mátion* (< *confírm*) *ìn<u>for</u>mátion* (< *infórm*)
pìg<u>men</u>tátion(< *pìgmént*) *sèg<u>men</u>tátion* (< *sègmént*)

These words are derived from the stem words in parentheses: for example, *àdvàntágeous* in (2a) is derived from *advántage*, and *ìnformátion* in (2b) is derived from *infórm*. These two types, (2a) and (2b), differ in the behavior of the stem stress: in *àdvàntágeous* in (2a) the stem stress appears as secondary stress in the derived word, as seen in the second syllable *vàn* of *àdvàntágeous*; in *ìnformátion* in (2b), on the other hand, stem stress does not surface on the second syllable *for* of *ìnformátion*, but is reduced to schwa.

In OT, Pater (2000) accounts for the difference between these types of words by *lexically* grouping those in (2a) into a special set, termed the "S_1" group. For this special "S_1" group, Pater (2000) argues, the highest-ranked constraint ID-STRESS-S_1 in the relevant constraint ranking in (3) ensures the appearance of secondary stress in this pretonic position, since the constraint ID-STRESS-S_1 respects the stem stress, as in *àdvàntágeous*:

(3) ID-STRESS-S_1 » *CLASH-HEAD » ID-STRESS » ALIGN-L

The words in (2b), on the other hand, are not grouped into the special S_1 set. Thus, for example, *ìnformátion* is accounted for by the "normal" ID-STRESS constraint being ranked lower than *CLASH-HEAD in the constraint ranking in (3).[2]

In sum, in Pater (2000) the words in (2a) are treated as "exceptions," while those in (2b) are treated normally. Notice here that in (3) an identical constraint, namely ID-STRESS, appears in *two* different positions of *one* constraint ranking: the one as the highest-ranked ID-STRESS-S_1, and the other as the ID-STRESS ranked lower than *CLASH-HEAD. Thus, the highest-ranked ID-STRESS-S_1 is used *only* for the exceptional S_1 group of words. We can therefore state that this is not an explanation, rather a description of exceptions.

In MT, Halle and Vergnaud (1987) view these two groups of words in the opposite way: those in (2a) are accounted for without using any exceptional treatment, that is, they are accounted for normally under their system of rules. On the other hand, those in (2b) receive exceptional treatment: according to Halle and Vergnaud the internal word structure of these words is flat, that is, without any embedded internal stem in the lexical representation, as shown in (4) for *ìnformátion* for example:

(4) [information]

This view is traditional within MT, applied first in Chomsky and Halle (1968). This means that the words in (2b) are "exceptions" to the cyclic application of rules to derived words. Thus, the two approaches are wholly inconsistent with each other on this point.

2.2. Tertiary stress

The next problem with OT and MT is the treatment of tertiary stress. Let us look at the examples in (5):

(5) *àdvântágeous càndêmnátion ìmpôrtátion càndênsátion*

In this and subsequent examples, tertiary stress is shown by a circumflex accent over the relevant vowel. Thus, in *àdvântágeous*, the second syllable *vân* bears tertiary stress, in contrast to the secondary stress described in (2a) above. The existence of tertiary stress in these examples is supported by the Data Clarification Method proposed in Yamada (2010), which we

will not discuss in the paper. However, in analyses in OT, including Pater (2000), tertiary stress is completely disregarded and is treated as secondary stress, as shown in (2a). In MT, for example in Halle and Vergnaud (1987), tertiary stress is treated in part, but without a full account.

2.3. Stress variants

The final problem of both theories is the existence of pronunciation variants. As shown in (6), some words have two or more stress variants:

(6) a. *àdaptátion àdâptátion* b. *accèssibílity âccèssibílity*
c. *demòbilizátion dêmòbilization* d. *elàstícity èlâstícity*

However, OT is unable to account for these stress variants, since as stated above there is no tertiary stress whatsoever in the theory data. Further, in MT, there is no principled account of such variants.

To summarize the observations in this section, there are three major problems with MT and/or OT. First, for canonical examples such as those in (2), the two theories take an opposite approach: one considers (2a) to be exceptions, while the other takes (2b) to be exceptions. Second, neither theory can account for the presence of tertiary stress. And third, neither theory can account appropriately for stress variants.

The discussion above shows that we cannot use either MT or OT, as they are unable to solve the issues highlighted here. Thus, we will attempt to develop a third way.

3. Setting and preliminary: canonical analysis and representation

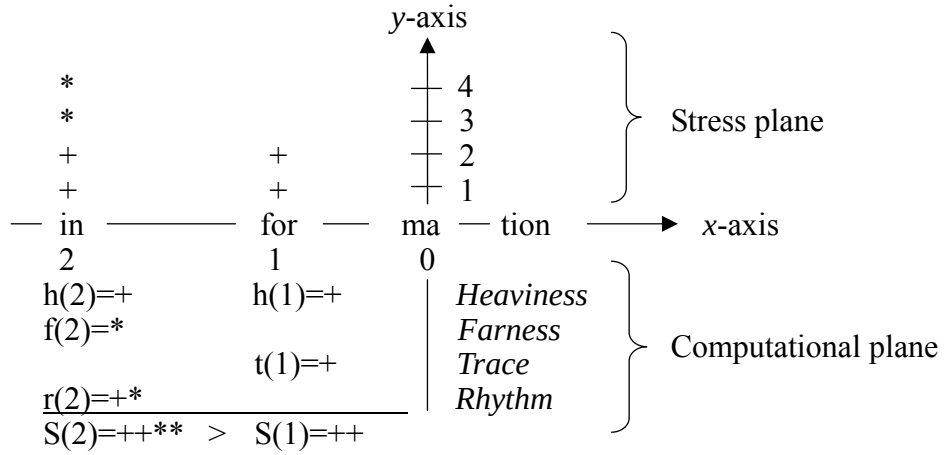
Within this new framework, as shown in (7), we propose that the subsidiary stress rule of words in English is composed of 16 "Positional Functions":

(7) Positional Function Theory
The subsidiary stress rule in English is composed of 16 Positional Functions.
$y = f_n(x)$ $[f_n(x) = y]$

We also postulate that stress assignment is computed by an algorithm in which a certain number of Positional Functions interact.

The following figure (8) is a canonical example, outlining the way stress contours are determined and represented in our theory, with the word *ìnformátion* as illustration:

(8) *ìnformátion* (< *infórm*) (2010)



In the discussions below, numerals such as (2010) in parentheses after examples indicate the stress values of the relevant syllables: 1 is primary, 2 secondary, 3 tertiary, and 0 unstressed.

We label the plane over the *x*-axis the "stress plane," and that under it the "computational plane." The syllable position on which primary stress is placed forms the *y*-axis. The syllable position where the *x* and *y*-axes intersect is numbered 0 on the *x*-axis, and labeled the origin of the coordinate axes. Syllables are counted leftward from the origin, thus 1, 2, 3, 4, and so on, under *x*-axis, according to the distance from the origin.

As in (7) above, the Positional Function is expressed by the formula $y = f_n(x)$. However, on the actual computational plane, we represent the formula in reverse as $f_n(x) = y$ in order to show the resulting values clearly. In the formula, *f* stands for a Positional Function, *x* the syllable position counted from the origin, and *y* the stress value of the Positional Function.

To return to (8) again, Positional Functions and their values are represented under the relevant syllables in the computational plane. Here, four types of Positional Functions are triggered: *Heaviness*, *Farness*, *Trace*, and *Rhythm*. *Heaviness* is triggered under a heavy syllable; *Farness* is activated under the leftmost syllable from the position of primary stress when the same type of syllable appears successively on the same level; *Trace* is activated under a syllable on which stress is given in an earlier cycle; and *Rhythm* is triggered under the leftmost syllable if the syllable immediately preceding the primary stressed syllable bears stress. For detailed definitions of the Positional Functions, see Yamada (2010).

Thus, in (8), *Heaviness* in the formulae *h*(*2*) = + and *h*(*1*) = + is triggered under the heavy syllables *in* and *for*, respectively, giving a stress value of "+" for each. *Farness* in *f*(*2*) = * is activated under the leftmost syllable, since the same type of syllable, in this case a heavy syllable, appears successively in positions 2 and 1, giving a value of * under the first syllable. Next, *Trace t*(*1*) = + is triggered under the *for* of the syllable numbered 1, since this syllable bears the stem stress of the verb *infórm*. And *Rhythm r*(*2*) = +* is activated on the leftmost syllable *in*, since the syllable *for* bears stress.

The values of the Functions are added vertically and are described on the bottom line. *S*(*2*) = ++** under the first syllable indicates that the sum of the values of the syllable numbered 2 is "++**", that is, four values of stress, and *S*(*1*) = ++ indicates that the syllable numbered 1 is

"++". Thus, the stress value of syllable number 2 is stronger than that of 1. The result is mapped onto the stress plane. Notice here that the stress value of the second syllable is considered to be zero, since the difference in value between the first syllable and the second syllable is two. This is based on the hypothesis postulated in Yamada (2010), which will not be discussed in more detail in this paper. Thus, the stress representation on the stress plane in (8) accounts for the stress pattern of the word *ìnformátion* (2010).

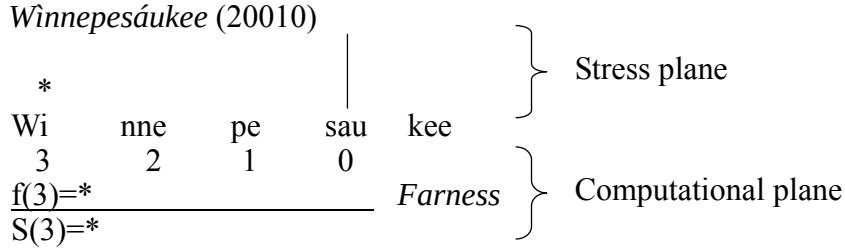
4. Basic concept

Let us now examine the following Functions individually in detail:

(9) a. *Farness* b. *Heaviness* c. *Trace* d. *Binarity*

In the word *Wìnnepesáukee* in (10), primary stress falls on the penultimate syllable and secondary stress on the first syllable:

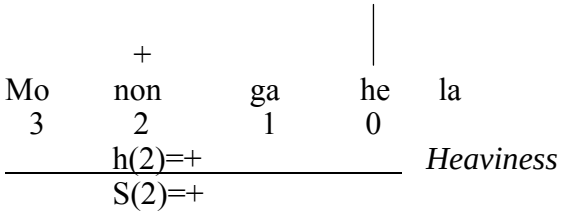
(10) *Wìnnepesáukee* (20010)



In order to ensure the secondary stress on the first syllable, we assume the Positional Function *Farness* in the phonology of English, which places subsidiary stress as far left as possible from the position of primary stress. In (10), the first syllable is the most distant from the primary stressed syllable *sau*. Thus, by definition, the Positional Function *Farness* (abbreviated here as "*f*") yields "*" as the value of the Function applied to syllable number 3. Since *Farness* is the only Function activated for this word, the stress value of *S*(*3*) will be one "*". This concludes the computation on the computational plane. The value of one * is then mapped onto the stress plane. Thus, the correct stress distribution of *Wìnnepesáukee* is obtained, since the stress on the first syllable is the strongest except for the primary stress on the penultimate syllable.

Next we will consider the word *Monòngahéla* in (11):

(11) *Monòngahéla* (02010)



Syllable number 2 of this word is heavy. Thus, *Heaviness* is triggered on the syllable by means of the formula *h*(*2*) = +. This stress value is mapped onto the stress plane, giving the desired stress pattern.

In the case of *ântìcipátion* in (12), *Heaviness* is activated on the syllable numbered 3, since the first syllable is heavy:

(12) *ântìcipátion* (< *antícipate*) (32010)

+					
*an	ti	ci	pa	tion	
3	2	1	0		
h(3)=+					*Heaviness*
S(3)=+					

However, this analysis will not result in a correct representation. Notice here that the noun *ântìcipátion* is derived from the verb *antícipàte*, which would be accounted for with the help of *Trace* as in (13) below. The analysis and representation in (13) is not what we want, however. The resulting stress pattern in (13) is again an incorrect 22010, in contrast to the desired pattern, 32010.

(13) *ântìcipátion* (< *antícipate*) (32010)

+		+				
*an		ti	ci	pa	tion	
3		2	1	0		
h(3)=+		t(2)=+				*Heaviness, Trace*
S(3)=+	=	S(2)=+				

What we need is tertiary stress on the first syllable and secondary stress on the second syllable. For this purpose, we have to find a device to augment the stress on the second syllable by one for this type of word. Close examination shows that this type of word contains a light syllable at position number 1, immediately preceded by the syllable on which *Trace* is triggered. This fact can be accounted for by postulating a Positional Function *Binarity*. The Positional Function *Binarity* is activated under a *Trace*-triggered syllable when the immediately following syllable is weak and unmarked for any other Function. Thus, in (14), under the syllable numbered 2, *Binarity* is activated by means of the formula *b*(*2*) = +:

(14) *ântìcipátion* (< *antícipate*) (32010)

		+				
+		+				
an		(ti	ci)	pa	tion	
3		2	1	0		
h(3)=+		t(2)=+				*Heaviness, Trace*
		b(2)=+				*Binarity*
S(3)=+	<	S(2)=++				

Note that we enclose the syllables paired by *Binarity* in parentheses to show the application of the function clearly. Consequently, the stress value of the syllable numbered 2 becomes two +'s. As the stress value of the first syllable is "+" by means of the formula *h*(*3*) = +, *S*(*3*) is weaker than *S*(*2*). The result is mapped onto the stress plane, yielding the correct stress representation of the word, 32010.

5. Positional Functions

A careful examination of examples discussed in previous studies leads to the conclusion that the subsidiary stress rule of words in English is composed of 16 Positional Functions. The

full definitions and list of Functions are given in Yamada (2010).

There are three types of Positional Function: *Intrinsic* Positional Functions, *Relative* Positional Functions, and Positional *Adjustment* Functions. (1) *Intrinsic* Positional Functions are functions whose stress "positions" are determined by the intrinsic character of the syllables themselves. For example, the Positional Function *Heaviness* is triggered on the position of a "heavy" syllable, giving "+" as its stress value. (2) *Relative* Positional Functions are functions whose stress positions are determined "relatively" by the relationship of the relevant syllable to another designated syllable. For example, in (8), *Farness* is a relative Positional Function in which a stress value "*" is given to the syllable leftmost from the position of primary stress. (3) Positional *Adjustment* Functions are the functions by which initial stress values on the computational plane are "adjusted" before they are sent to the stress plane. We will now look at typical examples of these three types of Positional Function.

5.1. Intrinsic/relative Positional Functions

Since in (11) and (14) above we have already shown examples of intrinsic Positional Functions, such as *Heaviness*, *Trace*, and *Binarity*, we will now take up relative Positional Functions below.

In (15) below, three relative Positional Functions are activated: *Farness*, *ACS*, and *Rhythm*:

(15) *còndênsátion* (< *condénse*) (2310)

*			
*	*		
+	+		
+	+		
con	den	sa	tion (< *condénse*)
2	1	0	
h(2)=+	h(1)=+		*Heaviness*
f(2)=*			*Farness*
	t(1)=+		*Trace*
	acs(1)=*		*ACS*
r(2)=+*			*Rhythm*
S(2)=++**	>	S(1)=++*	

As *Farness* and *Rhythm* have already been examined, here we will look at *ACS* or *Alveolar Consonant Sequence*. *ACS* functions between the underlined consonants /n/ and /s/ in this case. By means of this Function, the stress value of the heavy syllable *den* is augmented by one as the stressed syllable ends in the nasal /n/ immediately followed by the primary stressed syllable beginning with a voiceless alveolar consonant /s/. In (15), *ACS* gives the stress value "*" by means of the formula *acs*(*1*) = * under the syllable numbered 1. Thus, five types of Positional Functions are triggered for this case; their stress values are added vertically in the computational plane, then mapped onto the stress plane, giving the desired stress pattern.

The computational plane comprises not only the addition of stress values, but also reduction of values, as shown in (16):

(16) *elèctrícian* (< *eléctric*) (0210)

	*		
	+		
*	+		
e	lec	tri	cian
2	1	0	
	h(1)=+		*Heaviness*
	t(1)=+		*Trace*
	vas(1)=*		*VAS*
bna(2)=−			*BNA*
r(2)=+*			*Rhythm*
S(2)=* <	S(1)=++*		

In (16), two further Positional Functions are introduced: one is a relative Positional Function *VAS*, the other an intrinsic Positional Function *BNA*. *VAS* stands for *Velar-Alveolar Sequence*, which is activated between the underlined consonants on the syllables numbered 1 and 0. When a *Trace*-triggered syllable ending in the velar /k/ is immediately followed by the primary stressed syllable beginning with the alveolar /t/, *VAS* is operative under the *Trace*-triggered syllable, in this case the syllable numbered 1. *VAS* is a stress-addition Positional Function.

On the other hand, *BNA* is a stress-reduction Positional Function. *BNA* is short for "*Bare Nucleus Avoidance*." This function is activated under the underlined vowel of the first syllable. Notice here that the value of the formula is not a "+" or "*", but "−". Thus, by virtue of *BNA*, stress is reduced on a "non-branching bare nucleus at the leftmost edge of the word." In (16), under the first syllable, the stress value "−" in *bna*(*2*) = − and the value "+" of "+*" in *r*(*2*) = +* are offset, with only one "*" remaining for the syllable as *S*(*2*) = *. The stress value of "one" on the first syllable differs significantly from the stress value of "three" on the second syllable. As already shown in (8), when the difference in stress value between two successive syllables becomes two or more, the value of the weaker stress is reduced to zero. Thus, the desired stress pattern 0210 is obtained for this word.

Notice that, as shown in (17), we also have a stress variant 2310 for this word:

(17) *èlêctrícian* (< *eléctric*) (variant pronunciation) (2310)

*			
*	*		
+	+		
+	+		
e	lec	tri	cian
[+tense]			
2	1	0	
h(2)=+	h(1)=+		*Heaviness*
f(2)=*			*Farness*
	t(1)=+		*Trace*
	vas(1)=*		*VAS*
r(2)=+*			*Rhythm*
S(2)=++** >	S(1)=++*		

We can account for the stress variant as follows: the first vowel of the word is lexically marked as [+tense], which triggers *Heaviness* and accordingly *Farness* on this syllable. Consequently, the application of these Positional Functions by definition blocks the application of *BNA* under the first syllable. Thus, the sum of the stress values on the first syllable is "four," followed by a stress value of "three" on the second syllable, yielding the desired stress pattern of 2310 for this variant. In this way, we are able to treat stress variants.

The next example we will examine is (18):

(18) *Epàminóndas* (02010) (< ø) (02010)

	*			
	+			
E	(pa	mi)	non	das
3	2	1	0	
	b(2)=+			*EE-I* (*Binarity*)
	eeI(2)=*			*EE-I*
	S(2)=+*			

Here we find another Positional Function *EE-I*, which stands for *Edge Exemption I*. *EE-I* has a similar effect to *BNA*, avoiding stress on "the bare nucleus" at the left edge of the word. *EE-I* is triggered under the second syllable if the first syllable consists of a bare nucleus immediately followed by two successive light syllables. Application of *EE-I* is always paired with application of *Binarity* (which is distinct from the *Binarity* of (14) applied in isolation).

The word *ònomàtopóeia* in (19) has a 202010 stress pattern:

(19) *ònomàtopóeia* (202010) (< ø)

+		+				
(o	no)	(ma	to)	poei	a	
4	3	2	1	0		
fb(4)=+		fb(2)=+				*Free Binarity*
S(4)=+	=	S(2)=+				

This pattern is accounted for by *Free Binarity*. When two binary constituents can be constructed successively on the light syllables, *Free Binarity* is triggered on the left head of each binary constituent, giving a stress value "+". *Free Binarity* is not a relative but an intrinsic Positional Function. Nevertheless, it is mentioned here for comparison with the relative *Binarity*, which is paired with *EE-I* as in (18), and intrinsic *Trace*-activated *Binarity*, as in (14). *Free Binarity* is applied optionally, in contrast to other *Binarity* Functions.

5.2. Positional Adjustment Functions

In (20) below, three Positional Functions – *Heaviness*, *Trace*, and *Rhythm* – are triggered; however, the stress pattern is not the desired one:

(20) *dòmêstícity* (23103) (< *doméstic*)

```
  *          +          |
  +          +          |
 *do        mes        ti      ci     ty
  2          1         0
             h(1)=+          Heaviness
             t(1)=+          Trace
r(2)=+*                      Rhythm
S(2)=+*  =  S(1)=++
```

This shows an incorrect, even-stressed pattern in the first and second syllables. In order to obtain the desired stress pattern of 23103, we have to augment the stress on the first syllable by one, *before* the result from the computational plane is sent to the stress plane. This is achieved by a Positional *Adjustment* Function. In this case, *Rhythmic Adjustment* is applied as shown in (21):

(21) *dòmêstícity* (23103) (< *doméstic*)

```
  *                       |
  *          +            |
  +          +            |
 do        mes        ti      ci     ty
  2          1         0
             h(1)=+          Heaviness
             t(1)=+          Trace
r(2)=+*                      Rhythm
S(2)=+*  =  S(1)=++
ra(2)=*                      Rhythmic Adjustment
S(2)=+** >  S(1)=++
```

Rhythmic Adjustment adjusts the initial result on the computational plane by augmenting the leftmost syllable by one. These Positional Adjustment Functions differ from intrinsic or relative Positional Functions. Thus, we will create a new entry at the bottom of the computational plane as in (21).

The final examples in (22) and (23) are of stress variants:

(22) *àdâptátion* (2310) 4 3/5 (< *adápt*)[3]

```
  *                       |
  *          +            |
  +          +            |
  a        dap        ta      tion
  2          1         0          (S(2)=[+tense])
h(2)=+     h(1)=+          Heaviness
f(2)=*                     Farness
             t(1)=+        Trace
bna(2)=−                   BNA
r(2)=+*                    Rhythm
S(2)=+** >  S(1)=++
```

(23) *àdaptátion* (2010) 4 2/5 (< *adápt*)

```
                                  |
*                                 |
*                                 |
+                  +              |
a                  dap            ta      tion
2                   1             0              (S(2)=[+tense])
h(2)=+             h(1)=+                 Heaviness
f(2)=*                                    Farness
                   t(1)=+                 Trace
bna(2)=−                                  BNA
r(2)=+*                                   Rhythm
S(2)=+**     >     S(1)=++
                   sr(1)=−                Stress Reduction
S(2)=+**     >     S(1)=+
```

We can account for this difference by application of one of the Positional Adjustment Functions, namely *Stress Reduction* which reduces the weaker stress by one. In (23), the formula *sr*(*1*) = − is triggered under the second syllable; however, in the case of (22), as this is an optional Positional Function, it is not triggered in those who pronounce the word as *àdâptátion*, 2310.

7. Conclusion

In this paper, we have briefly shown that we can account for the subsidiary stress assignment of words in English in a principled way if we accept that the subsidiary stress rule in English is composed of the 16 Positional Functions postulated in Yamada (2010). Using this framework, we are able to account for the different stress patterns shown in (2), the existence of tertiary stress as discussed in (5), and the stress variants in (6).[4]

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Notes

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[1] In the study, "subsidiary stress" means "secondary and tertiary stresses."

[2] *CLASH-HEAD blocks the pretonic stress.

[3] In (22) and (23), the numeral and fraction after the stress value refer respectively to the number of entry of the particular variant pronunciation and the ratio of the listing of the variant as the first entry in five major dictionaries, following the Data Clarification Method set out in Yamada (2010). For example, in the case of "4 3/5" in (22), the variant appears in four of the major dictionaries, with three of the five main dictionaries listing it as the first entry.

[4] Yamada (2010) also discusses the method of data clarification in detail as well as reviewing previous studies in the field of subsidiary stress.

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