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The Use of Prosodic Information in Word Recognition

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ABSTRACT

In languages with variable stress placement, lexical stress patterns can convey information about word identity. The experiments reported here address the question of whether lexical stress information can be used in word recognition. The results allow the following conclusions:

1. Prior information as to the number of syllables and lexical stress patterns of words and nonwords does not facilitate lexical decision responses (Experiment 1).
2. The strong correspondences between grammatical category membership and stress pattern in bisyllabic English words (strong–weak stress being associated primarily with nouns, weak–strong with verbs) are not exploited in the recognition of isolated words (Experiment 2).
3. When a change in lexical stress also involves a change in vowel quality, i.e., a segmental as well as a suprasegmental alteration, effects on word recognition are greater than when no segmental correlates of suprasegmental changes are involved (Experiments 2 and 3).

4. Despite the above findings, when all other factors are controlled, lexical stress information per se can indeed be shown to play a part in the word-recognition process (Experiment 3).

INTRODUCTION

In languages with lexical stress, polysyllabic words have one syllable marked for higher stress than the others.[1] In some such languages, stress is bound to a particular syllable—Polish, for example, places stress on penultimate syllables. In others it is variable and is therefore available as a potential determinant of word identity. Minimal pairs of unrelated words whose pronunciation differs only in stress pattern (e.g., "forgoing"–"foregoing") are, however, very rare in English and in most other variable stress languages. Stress contrasts between related words (e.g., "SUBject"–subJECT"; "PERmit"–"perMIT") are more common, but the pairs of words in question usually differ segmentally, in vowel quality, as well: unstressed vowels are reduced.

Thus listeners are rarely forced to rely solely upon prosodic (i.e., lexical stress) cues to word identity. Nevertheless, it is clear that prosodic information could often help to identify words. For example, whereas dozens of relatively common English words begin with the three segments [stæ], in only three—"stampede," "stagnation," "statuesque"—is the first syllable unstressed. A hearer, given these three word-initial segments plus the fact that the vowel was unstressed, and asked to guess the intended word, would thus be far more likely to guess correctly than a hearer given the segmental but no prosodic information.

There is little evidence, however, that lexical stress plays a dynamic role in speech perception. Sentence accent clearly contributes to sentence perception (Shields, McHugh, & Martin, 1974; Cutler, 1976), but studies that are frequently cited as demonstrating that stress patterns influence word perception (e.g., Bansal, 1966; Garnes & Bond, 1975) have failed to separate the effects of stress per se from the correlated effects of vowel quality. The present chapter attempts to establish whether lexical stress

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[1]This stress marking is, properly speaking, an abstraction, which may or may not be realized in physical differences between syllables in a particular utterance. We will beg the question of the relationship between stress marking and the physical properties of utterances here (for a more detailed discussion, especially of the theoretical assumptions implicit in choices of terminology, see Ladd and Cutler, 1983); all our experiments involved presentation of words in isolation—i.e., in citation form pronunciation—with clear physical differences between syllables with different stress marking.

information is actually drawn upon in word recognition. Two experiments that examine whether prior knowledge of stress pattern facilitates lexical access are reported, followed by a discussion of whether stress information might be used systematically as a cue to form class; and a final experiment in which word stress is distorted is then described, and the resultant effects upon word recognition are measured.

DOES PRIOR KNOWLEDGE OF LEXICAL STRESS SPEED WORD RECOGNITION?

In sentence contexts, anticipatory information about the stress patterns of words could be provided by sentence rhythm. Experiment 1 was designed to investigate whether such prior knowledge facilitates word identification, using a lexical decision task with visual presentation (1a) and auditory presentation (1b), and comparing pure versus mixed presentation of monosyllables, bisyllables with stress on the first syllable, i.e. strong–weak (SW) stress, and bisyllables with second-syllable, i.e. weak–strong (WS) stress. If listeners can use anticipatory information about stress pattern, they should recognize words more quickly in pure lists (stress priming) than when words with different stress patterns occur in unpredictable sequence.

Experiment 1a

Materials. Forty-four SW (e.g., "tiger") and 44 WS ("canoe") bi-syllables were selected and each word matched with a one-syllable word ("blaze") on phonemic and orthographic length and frequency of occurrence, for a total of 176 words. A total of 112 word-like nonwords ("stemp") were constructed, matched on syllable structure and length to the words.

The items were divided into two equal-sized subsets, counterbalanced for number of syllables and stress pattern, with orthographic and phonemic length, and, in the words, frequency also matched as closely as possible.

Procedure. Subjects, tested individually, saw the stimuli as negative slides backprojected through a green filter onto a screen. Each item was presented for 1 sec with a 3-sec intertrial interval, and subjects' key-press response times were recorded from separate timers for "yes" and "no" responses.

The items were presented in eight lists of 39 items each, each list containing 22 experimental words, 14 nonwords, and three warm-up items, of which at least two were nonwords. A list of 24 practice items began the experiment.

TABLE 11.1

Mean Lexical Decision Times (msec) to Bisyllables with Lexical Stress
on First Syllable (SW), Bisyllables with Lexical Stress on Second Syllable
(WS), and Monosyllables, Comparing Presentation in Lists that were
Homogeneous vs. Mixed as to Lexical Stress

a. Visual Presentation

		Words		Nonwords	
		Pure	Mixed	Pure	Mixed
Bisyllabic	SW	567	571	707	721
	WS	619	635	728	745
Monosyllabic		600	608	702	729

b. Auditory Presentation

		Words		Nonwords	
		Pure	Mixed	Pure	Mixed
Bisyllabic	SW	745	754	779	809
	WS	790	800	963	882
Monosyllabic		729	733	775	796

Sixteen subjects from the University of Sussex community each saw four
mixed lists of one- and two-syllable items, two lists of one-syllable items
only, one list of SW bisyllables, and one list of WS bisyllables. Eight
subjects saw subset A items in pure lists and subset B items in mixed lists,
while for the others this condition was reversed. The lists were presented in
a different order to each subject; at the beginning of each list, subjects
were told whether it was a mixed list, a list of bisyllables with initial
stress, etc.

Results. Mean response times for each condition are presented in
Table 11.1a. For the words, the effects of the blocking manipulation
were minimal and did not reach significance in either subjects or item
analysis. The effect of syllable structure was, however, significant
[min F' (2, 170) = 7.4, $p < .001$]. Scheffé post-hoc tests revealed that all
three conditions differed significantly from one another. In the nonwords
analysis, no effect reached significance in both analyses.

Experiment 1b

Materials. The words were the same items as those used in Experiment
1a. There were 160 nonwords, including most of the nonwords from
Experiment 1a. Distribution of number of syllables, stress pattern, and

phonemic length was proportionately the same in the nonwords as in the words.

Procedure. The items were blocked as in Experiment 1a, except that each block contained 22 words, 20 nonwords, and 4 warmup items (2 of which were words). The 16 blocks (of which any one subject heard 8) were recorded by a native speaker of British English, at a rate of 1 word every 3 sec. As in Experiment 1a, each item was heard by half the subjects in a mixed list and half in a pure list; list constitution and presentation order were constrained as in Experiment 1a. Response times were measured from each word's onset and recorded as in Experiment 1a.

Sixteen subjects from the University of Sussex community heard the material over headphones. Timing and data collection were controlled by a PDP-12 computer.

Results. The results are presented in Table 11.1b. As can be seen, the effect of blocking is again minimal and did not reach significance, either for the words or for the nonwords, in either analysis. The effect of syllable structure, however, was significant both for the words [min F' (2, 174) = 9.87, $p < .001$) and for the nonwords (min F' (2, 72) = 4.36, $p < .05$). Scheffé post-hoc tests revealed that in both the words and the nonwords the source of the syllable structure effect was that WS bisyllables elicited significantly slower responses than either monosyllables or SW bisyllables. In both parts of the experiment, therefore, WS words were recognized more slowly than words with stressed first syllables (SW and monosyllables).

Experiment 1, by failing to show a facilitatory effect of blocking by syllable structure and stress pattern, provided no evidence that prior knowledge of prosodic structure can be used to speed word identification. Thus these results rule out a model of lexical access in which the lexicon can be partitioned by stress pattern in such a way that if stress pattern is given, the number of potential word candidates is reduced. There are, however, other ways in which lexical stress information, including anticipatory information in sentence context, might be used in word understanding. For example, consider the strong correspondences that exist in English between word class and SW or WS stress patterns in bisyllables: the former are more likely to be nouns, the latter to be verbs. Fay (1975) has presented evidence that prior knowledge of word class can speed lexical access and has used this evidence to argue that lexical partitioning by grammatical category is indeed able to reduce the size of the candidate set in word recognition. In Experiment 1, grammatical category was not controlled. Our next study, therefore, addressed the question of whether stress pattern information can facilitate word recognition indirectly, via the information it may provide about grammatical category.

CAN STRESS PATTERN PROVIDE CUES TO GRAMMATICAL CATEGORY?

In attempting to establish whether or not listeners can exploit stress pattern information in bisyllables in the identification of word class, we used a task that required the identification of spoken two-syllable words as nouns or verbs. If words that match the canonical stress pattern of their part of speech can be identified more quickly than words that deviate from canonical form or, alternatively, if stress pattern predicts the part of speech of a heard word, so that two-syllable SW words are expected to be nouns and WS to be verbs, then listeners should recognize SW nouns and WS verbs faster than WS nouns and SW verbs.

Experiment 2

The task chosen was an auditory analogue of a study by Forster and Bednall (1976). Subjects heard a word in the context "to ———" or the context "the ———," and indicated whether or not what they had heard constituted a grammatical phrase.

Materials. Twenty SW nouns ("apple"), 20 WS nouns ("cigar"), 20 SW verbs ("borrow"), 20 WS verbs ("await"), 20 one-syllable nouns ("clause"), and 20 one-syllable verbs ("bless")[2] were matched word-for-word across conditions for frequency of occurrence and phonemic length (except that the one-syllable words were, unavoidably, somewhat shorter). Three further words for each condition were chosen as practice words. Each word was taperecorded in isolation, digitized, spliced to an instance of the context word "to ———" and an instance of the context word "the ———," and recorded on tape. A timing mark on the tape's second channel was aligned with the word onset.

Four tapes were prepared. Each began with 18 practice trials, half grammatical (e.g., "to punish," "the sleeve") half ungrammatical (e.g., "to lagoon," "the crave"), followed by the 120 experimental words (in independent random order for each tape). Each tape had equal numbers of words in each condition. The words were divided into two equal-sized counter-balanced subsets. Subset A words appeared in appropriate context frame on two tapes and in inappropriate context frame on the other two tapes, with frame assignment reversed for subset B. The tapes ended with two "trick" trials, on which words were presented whose part of spech changes as their lexical stress changes: "conDUCT" (verb) vs. "CONduct"

(noun), "imPORT" vs. "IMport," "perMIT" vs. "PERmit," and "de-CREASE" vs. "DEcrease." Each tape had one such word in the "to ———" frame, and one in the "the ———" frame; in all cases, stress was inappropriate for the frame, e.g., "to CONduct," "the conDUCT." Each of these eight items (four words, each in two stress patterns) appeared on only one tape.

Procedure. Six subjects from the University of Sussex community heard each tape over headphones and pressed separate response keys to signify whether or not the two words spoken as a phrase formed an acceptable sequence. Response times were measured and collected by a Motorola 6809 microcomputer.

Results. Mean RTs (after eliminating responses over 2500 msec) and error rates, excluding the final trick trials, appear in Table 11.2. There was no facilitation for words with stress patterns appropriate to their part of speech. The interaction between acceptability, part of speech, and stress pattern was nonsignificant in both the subject and item analyses. However, Yes judgments were significantly faster than No [min F' (1, 34) = 39.21, $p < .001$], and there was a significant effect of stress pattern (min F' (2, 156) = 6.55, $p < .05$). Scheffé post-hoc tests showed the source of this effect to be significantly faster RTs to SW words (1054 msec) than to either WS words (1144 msec) or one-syllable words (1121 msec). That is, once again SW words were perceived more quickly than WS words. However, on further analysis this effect appears to be artefactual. WS words tend to be acoustically longer than SW words, and there is evidence (K.I. Forster, personal communication) that word recognition latency correlates very highly with acoustic length. Accordingly, we measured the duration of all stimulus words and statistically adjusted our obtained RTs for these measurements. The mean of the correlations within each experimental condition between word duration (measured visually from start to end of

TABLE 11.2

Mean Phrase Acceptability Decision Times (msec) and Error Frequencies for Verbs and Nouns that were Bisyllables with First Syllable Stress (SW), Bisyllabic with Second Syllable Stress (WS), or Monosyllabic, in Acceptable ("to" + verb; "the" + noun) vs. Unacceptable ("the" + verb; "to" + noun) Phrase Combinations

	Verbs			*Nouns*		
Acceptability	*SW*	*WS*	*Mono*	*SW*	*WS*	*Mono*
Acceptable	960	1042	1035	970	1099	1034
	(7)	(3)	(15)	(18)	(11)	(19)
Unacceptable	1134	1205	1218	1152	1229	1197
	(19)	(16)	(36)	(10)	(12)	(8)

the word's digitized waveform) and RT was 0.289, and the mean slope of the regression function relating RT to word duration was 0.624 (mean duration of SW words was 353 msec, WS words, 459 msec, and one-syllable words, 372 msec). Analyses of variance conducted on the regressed RTs yielded results equivalent in level of significance to those from the analysis of uncorrected RTs, except that the corrected RT to SW items (1066 msec) did not differ significantly from the corrected RT to WS items (1081 msec), while both were shorter than that for monosyllabic items (1119 msec). Thus the RT difference between SW and WS words appears to be only a reflection of differences in acoustic length.

The error data for Experiment 2 were analyzed separately, and they showed, as expected, significantly more errors to unacceptable than to acceptable phrases. There was also a main effect of syllable structure and interactions between grammatical category and (a) syllable structure and (b) acceptability.

Finally, the results of the trick trials can be summarized as follows: Subjects were more willing to accept leftward shift than rightward ("to SW" received 20 Yes responses, 4 No; "the WS" 6 Yes, 17 No) and accepted shifts that did not change vowel quality (18 Yes, 5 No) more often than those that did (8 Yes, 16 No). Thus "to SW" with no vowel change was acceptable to all subjects (and RTs were comparable with those of Table 11.2); "the WS" with vowel change was unacceptable to all subjects.

The results of this experiment show no evidence for a systematic use of stress pattern as a cue to grammatical category. However, the results of the trick trials do suggest strongly that some forms of mis-stressing may be more acceptable than others. This latter issue was explicitly investigated in the next experiment.

IS CORRECT STRESS IMPORTANT FOR WORD RECOGNITION?

None of the experiments so far has directly tested whether listeners necessarily use stress information as information relevant to identifying individual words. The most straightforward test of this is to determine whether distortion of normal word stress information impairs word recognition. Experiment 3 was therefore designed to assess the effects on word identification of different types of mis-stressing: shifts from SW to WS, and from WS to SW; shifts that did or did not involve vowel reduction. To ensure that the words were fully recognized, subjects were required to make a semantic judgment about each one.

Experiment 3

Materials.   Ninety-six two-syllable nouns were chosen, clearly identifiable (according to preliminary norms) as having physical vs. mental referents and having no morphological relatives with different stress patterns. (The mental–physical decision was used because it enabled approximately equal numbers of two-syllable nouns to be assigned to each response category and because pilot testing indicated that the decision—which clearly requires full word recognition—was an easy and natural one to make.) Half of the 96 nouns had SW stress, half WS. Half of each of these groups had vowels normally pronounced unreduced in both syllables and naturally pronounced unreduced when stress was shifted (e.g., "nutmeg," "typhoon"). The other half had [ə] in their normally W syllable ("wisdom," "deceit"); these syllables were pronounced in unreduced fashion when stressed. Fourteen of the words in each of the groups thus defined—SW Unreduced, SW Reduced, WS Unreduced, WS Reduced—had a physical referent, and 10 had a mental referent. (Because of an experimenter error, one word was omitted from the WS Unreduced Mental group, being replaced by a repetition of a word from the WS Reduced Mental condition. Thus, there were only 9 words in the former condition.)

Two lists of words, differing in which were to be mis-stressed, were constructed. Word sequence was the same in both lists, except that words correctly stressed in List 1 were mis-stressed in List 2, and vice versa. A single constrained randomization was devised, in which the first 16 trials (after 25 practice and 4 warm-up trials) had exactly one instance of a word in each condition, and the first 48 trials had exactly half the words in each category. The list was edited so that no clearly semantically related words appeared close together and no runs of a single decision (mental or physical) longer than seven occurred. A native speaker of British English with speech training taperecorded both lists, allowing approximately 3 sec between words.

Procedure.   Thirty-two subjects from the Sussex University community (16 to each tape) heard the material over headphones. They first judged the practice words, all correctly pronounced. Then they were told that they would hear some mispronounced as well as some properly pronounced words, and that they were to continue making the physical/mental decision as quickly as possible, ignoring mispronunciations. After four warm-up words, the experimental trials were presented. A Motorola 6809 microcomputer timed the responses, measuring from the point where a voice key responded to the speech signal on the tape to the point at which the subject pressed a response key. All words were later digitized, and the

TABLE 11.3

Mean Mental–Physical Decision Times (msec) to Bisyllabic Words with First Syllable (SW) vs. Second Syllable (WS) Stress, and Reduced vs. Unreduced Vowels in the Normally Unstressed Syllable

		Correct	Mispronounced	Δ
WS	reduced	934	1071	137
	unreduced	982	1026	44
SW	reduced	892	1045	153
	unreduced	882	1026	144

Words were presented either correctly pronounced, or mispronounced such that stress fell on the syllable normally unstressed.

distance from visually-identified word onset to where the voice key fired during the experiment was measured. Each RT was corrected by this value, so that all RTs were, in effect, measured from word onset.

Results. Mean RTs (excluding responses longer than 2 sec) are presented in Table 11.3. There was a strong effect of mispronunciation [min F' (1, 118) = 50.36, $p < .001$]. Two differences between normally SW and normally WS words were significant in both subjects and items analyses but failed to reach significance on min F': (1) normally SW words produced overall faster RTs; and (2) normally SW words produced a greater mispronunciation effect. Further analyses were conducted on the normally WS and the normally SW words separately. The mispronunciation effect was significantly smaller for unreduced than reduced words in the former analysis (min F' (1, 72) = 4.19, $p < .05$), but not in the latter analysis (both $F1$ and $F2$ less than 1).

As in the previous experiment, the faster RTs to normally SW words proved to be a function of word length. Again we measured word duration and reanalyzed the results, with the RTs regressed against word length. This analysis yielded a mean correlation of 0.262, a mean slope of 0.404, and differences in word duration between correctly pronounced and mispronounced words (647 vs. 679 msec), between words pronounced with SW and with WS stress patterns (635 vs. 691 msec), and between words with vowel reduction and words with only unreduced vowels (649 vs. 677 msec). Analyses of variance of the corrected RTs, like the analyses of uncorrected RTs, produced a significant mispronunciation effect and a significantly greater mispronunciation effect for reduced than for unreduced words in the normally WS, but not in the normally SW words. However, both the effect of canonical stress pattern and its interaction with mispronunciation yielded Fs less than 1 in both analyses of the corrected scores.

The main effect of mispronunciation shows that correct stress pattern is important for efficient word identification. As expected, the stress-correlated distinction between full and reduced vowels proved very important: reducing a full vowel or giving full weight to a reduced vowel made words difficult to recognize. But even in the absence of vowel quality differences, mis-stressing hampered word recognition.

Discussion

The demonstration in Experiment 3 that mis-stressed words are harder to identify is strong evidence that lexical stress information indeed plays an important role in word recognition. If a polysyllabic word is pronounced in isolation, it will be recognized more quickly if its stress-marked syllable is actually realized as stressed. Correspondingly, one may assume that a polysyllabic word that occurs in rhythmically stressed position in a longer utterance will only be recognized with maximum speed if the stress is realized on that syllable of the word which is marked to receive it.

As we pointed out above, in sentence contexts prosodic structure could give considerable advance information about lexical stress patterns. It is known that listeners use prosodic structure to direct their attention to the location of sentence accents. Cutler (1976) spliced an acoustically identical word into two sentence contexts that differed only prosodically, in that in one the prosody conformed with accent occurring at the point where the word was spliced in, while in the other it did not. Listeners responded to a target sound significantly faster on the word spliced into accented position than on the word spliced into unaccented position, indicating that information in the preceding prosody had enabled them to direct attention to the location of accent. Shields, McHugh, and Martin (1974) also measured RT to a target sound beginning a word in accented position in a sentence and showed that listeners responded more quickly if stress in that word fell on the *syllable* containing the target than if it fell on another syllable.

These effects suggest that part of the information that listeners perceiving a sentence extract from the prosodic patterning may concern lexical stress placement in upcoming words. There are at least two ways in which learning lexical stress patterns in advance might be of advantage in sentence comprehension. The first is the suggestion raised earlier, that knowing the stress pattern of the word to be recognized reduces the size of the candidate set—only words with the appropriate stress pattern need be considered. The present results, however, cast doubt on such an explanation. Prior knowledge of a word's stress pattern did not facilitate making a lexical decision about it (Experiment 1), nor did concordance of a word's stress pattern with the typical pattern for its grammatical category facilitate recognizing its category (Experiment 2). In other words, our listeners did

not appear to be able to use lexical stress in an anticipatory fashion at all—either directly, or indirectly via systematic relationships between stress pattern and word class. Admittedly, our present data do not conclusively rule out the possibility of predictive use of lexical stress in *sentence* perception; but they do demonstrate that listeners fail to use prosodic information that is potentially of benefit, and no contrary evidence exists to suggest that prosodic information that cannot be used in isolated word recognition can be used when word recognition takes place in sentence context. (Note that the findings of Shields et al. cannot be ascribed to a lexical effect, since their target-bearing "words" were in fact nonsense, e.g., "BENkik" vs. "benKIK.")

A second possibility (suggested by Cutler, 1976) is that a word's stressed syllable forms the basis for its lexical classification and hence for its retrieval from the lexicon, so that identification of a polysyllabic word cannot begin until the stressed syllable has been located. If this were the case, it would clearly be of value for listeners to use cues in the sentence prosody to predict which syllable of a word would be stressed. Moreover, this hypothesis predicts a subsidiary finding of our experiments, namely that words with SW stress should be recognized faster than words with WS stress, because in SW words the stressed syllable is heard earlier. Unfortunately this finding proved, as reported above, to be an artefact of word-length differences; when length is controlled, SW words are apparently identified no faster than WS words.

Overall, then, our findings provide no support for a predictive use of lexical stress information in word recognition. They do, however, indicate that canonical stress pattern is part of the lexical specification to which listeners refer when identifying a polysyllabic word. Mis-stressing a word hinders its recognition, just as would mispronunciation of part of its segmental structure.

Finally, let us consider those of our results in which it would appear that stress failed to affect word recognition. In Experiment 2, subjects classified "DEcrease" and "IMport" as verbs as readily as they classified canonically SW verbs. In Experiment 3, subjects were slowed only 44 msec by normally WS items with unreduced vowels when they were pronounced with a SW stress pattern, and close inspection of the data indicated that all of this effect was due to only 5 (of the total 23) words. Although SW pronounced as WS seems to be difficult to process, then, WS pronounced SW does not seem to cause particular difficulty as long as no vowels change.

This asymmetry in fact reflects an asymmetry in the English language. It is well known to linguists (see, e.g., Bolinger, 1981) that word stress can shift from its citation form location in response to the demands of sentence rhythm; thus "he is unKNOWN" but "the UNknown SOLdier." However, such stress shifts are strictly constrained: the stress can shift only to a full

syllable, and only to a syllable earlier in the word than the syllable marked for citation-form stress. Thus although "envelope" ends in a full syllable, it is not possible to make a phrase like "oPAQUE ENvelope" more rhythmic by pronouncing it "oPAQUE enveLOPE". Some right shifts do, in practice, occur in actual language performance, but they are characteristic of the final word of an excited utterance[3] and do not occur in "sober" speech. By contrast, the rhythmically determined left shifts are *obligatory*—"the unKNOWN SOLdier" is as wrong as "oPAQUE enveLOPE."

Our finding that subjects are not bothered by WS stress patterns becoming SW as long as only full syllables are involved seems, therefore, to be a consequence of the fact that any full syllable that precedes the stressed syllable of a word can itself be realized as stressed under appropriate contextual circumstances. The mis-stressed words that our subjects perceived easily were those in which the stress shift confirmed to the constraints on lexical stress realization in English. The mis-stressed words that they found hard to recognize, on the other hand, were exactly those that violated these constraints.

We hypothesize, therefore, that unreduced WS words such as "typhoon" are encountered sufficiently often in rhythmically constrained SW pronunciation that their SW form has achieved the lexical status of an optional pronunciation. The same would then be true of "IMport" and "DEcrease" as verbs; each of these happens to have an antonym which differs from it in prefix only,[3] so that listeners are often exposed to contrastive accentuation of the prefixes ("Britain EXports whisky, IMports wine").

ACKNOWLEDGMENTS

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[3]We are grateful to D. L. Bolinger for bringing this to our attention.

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