

Patterns of English Word Stress by Native and Non-native Speakers

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1. Introduction

While early impressionistic studies (Pike, 1945) defined stress as modification of pitch, loudness, and duration, later investigations, as summarized by Lehiste (1970), included acoustical measurements of fundamental frequency, amplitude, and length in order to determine the extent of their contribution to stress. Taking into account these acoustic parameters of speech sounds, stress has been investigated in both perceptual and production modes. Perceptually, loudness appears to be a weaker cue for stress than either duration or pitch. The perception of stress, however, does not seem to depend upon any one, or any combination of acoustic parameters. Speakers apparently have considerable latitude in the use of acoustic parameters. Lieberman (1967) found a higher percentage use of increases in frequency, amplitude, and length in stressed syllables by native English speakers on both initial stressed and second stressed syllables in words.

Non-native speakers of English either fail to use certain acoustic parameters or use them inappropriately in their speech patterns. Noteworthy is Adams' study (1979) in which she found similar performance by both native and non-native speakers for the production of stressed syllables but not for unstressed syllables in nursery rhymes and contextual speech.

This study was designed to compare the acoustical characteristics of fundamental frequency, amplitude, and length of English stressed and unstressed syllables in speech of native and non-native speakers and to interpret the findings in terms of word stress.

2. Method

2.1. Subjects

Two groups of subjects participated. Three were monolingual native American English speakers attending a midwestern university. Six were non-native English speakers enrolled in an English pronunciation class. Though their background in English differed, the students had adequate command of English to enroll in the University, according to the scores made on the Michigan Test of English Proficiency. Each spoke natively a different lan-

guage: Chinese (Taiwan), Hausa, Japanese, Korean, Persian, and Spanish (Colombia). All were male.

2.2. Materials

Five types of test words were selected: 1) prefixed words with second syllable stress, such as *confess*; 2) the same words with an *-ion* suffix, e.g. *confession*; 3) and 4) words which change stress pattern upon suffixation, such as *confirm* and *confirmation*; 5) words of similar phonetic shape but initial syllable stress, such as *conquer*. There were 25 different words, five of each type.

2.3. Procedure

Each subject recorded the prepared word list three times, in three different orders. For each token, the peak frequency and amplitude of the first two syllables were measured, using a Voice Identification Pitch Analyzer (PM 100). The length of the syllables was measured from the amplitude trace. Tokens which could not be segmented were measured from spectrograms (approximately 15% of the corpus). Reliability was obtained on ten items from the two researchers who measured the acoustic parameters. There was 90 percent agreement for frequency within three Hz or less, 100 percent agreement for amplitude within two dB or less, and 70 percent agreement for length within 10 msec or less.

Average fundamental frequency, amplitude, and length were computed for each measured syllable for each of the five word types. Data from the three Americans were combined for comparison with each of the measures for the non-native English speakers.

3. Results

3.1. Fundamental frequency

The Americans exhibited the expected fundamental frequency differences distinguishing stressed from unstressed syllables in the prefixed two and three syllable words (*confess*, *confession*, *confirm*). The Americans tended to produce syllables with secondary stress and reduced syllables, as in *confirmation*, with essentially the same fundamental frequency. In words such as *conquer*, the unstressed syllable was produced with a somewhat higher average fundamental frequency than the stressed syllable.

All non-native speakers but the Persian used fundamental frequency in a way similar to the American pattern for the prefixed one and two syllable words, as shown in the first three comparisons in Figure 1, panel a. The stressed syllable was associated with a higher fundamental frequency than the unstressed. The Japanese speaker, however, tended to show a greater relative pitch difference between the two syllables than the other speakers.

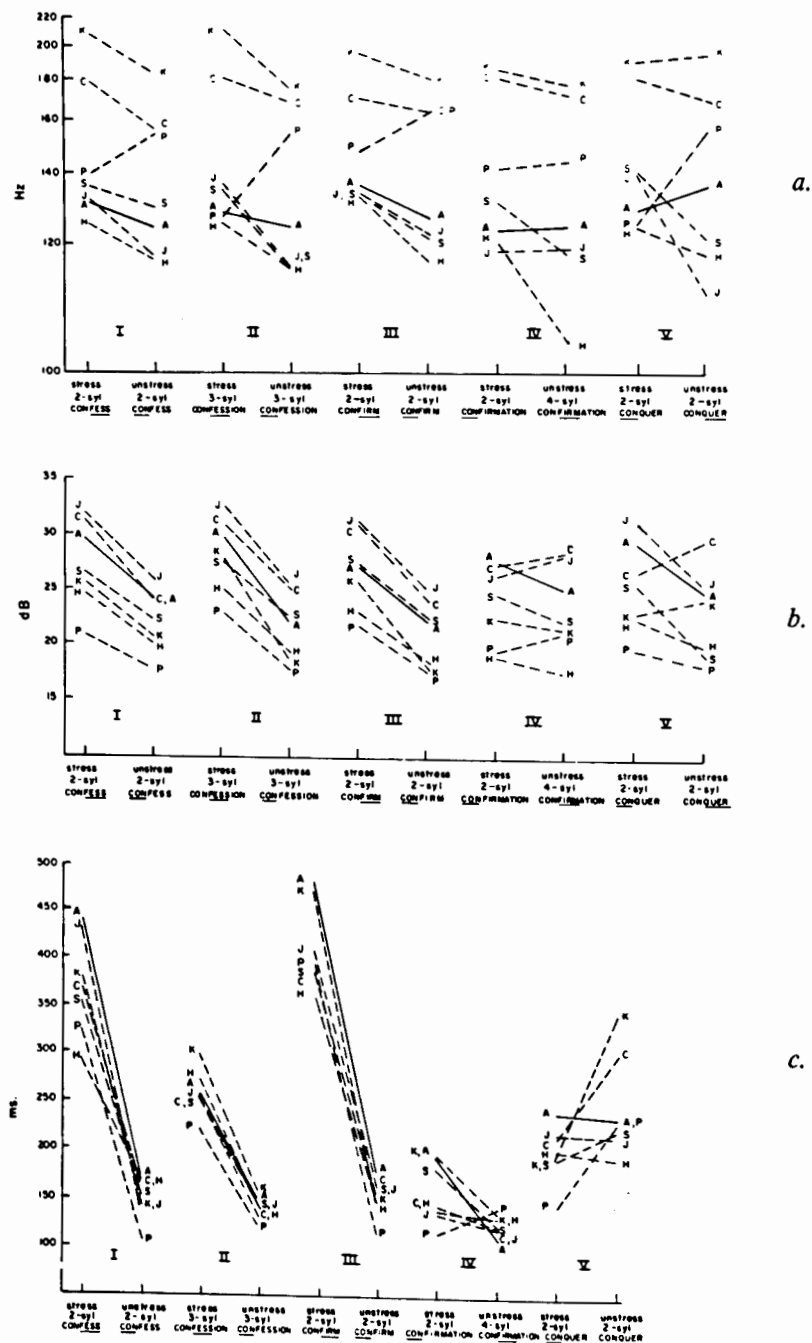


Figure 1. Comparison of stressed and unstressed syllables in the speech of native and non-native speakers. Speakers are identified by letter: A-American, C-Chinese, H-Hausa, J-Japanese, K-Korean, P-Persian, and S-Spanish. Panel a: Change in frequency (Hz) from stressed to unstressed syllables; Panel b: Change in amplitude as measured in decibels (dB); Panel c: Change in length as measured in milliseconds (ms).

The Persian speaker consistently used a higher fundamental frequency with unstressed than the stressed syllables, contrary to the American pattern. For words of the type *confirmation* and *conquer*, both the Spanish and the Hausa speakers used an extensive frequency drop from the stressed to unstressed syllable (Comparisons IV and V in Figure 1).

3.2. Relative amplitude

The American speakers and all the non-native speakers seemed to employ similar relative amplitude differences for the two and three syllable prefixed words, in that the amplitude of stressed syllables was higher than that of the unstressed syllables. These data are included in the first three comparisons of Figure 1, panel b. For the first two syllables of words such as *confirmation*, three of the non-native speakers (Persian, Chinese, Japanese) produced the second syllable with an increase in amplitude, rather than with the decrease found for native speakers. For words such as *conquer*, the Korean and the Chinese speakers tended to produce both syllables with equal amplitude.

3.3. Length

As in their use of amplitude, the non-native speakers were very similar to the Americans in using length as a correlate of stress for the two and three syllable prefixed words, as shown in the first three comparisons of Figure 1, panel c. Although Americans made the reduced syllable shorter than the initial syllable in *confirmation*, only the Korean and the Spanish speaker did so as well. The other speakers tended to make both syllables approximately equal in length. For words such as *conquer* the Americans as well as the Japanese and Hausa speaker used syllables of nearly equal length. The Persian, Chinese, and to a lesser extent, the Spanish speaker, prolonged the second syllable so that its length exceeded that of the first.

4. Discussion and Conclusion

The six non-native English speakers were able to control appropriately the acoustical parameters associated with lexical stress, although the Persian speaker was less successful than the others in producing appropriate fundamental frequency differences. They typically produced words such as *confess*, *confirm*, and *confession* with appropriate fundamental frequency, amplitude, and length differences between the stressed syllable and the prefix, though on occasion with somewhat exaggerated values.

The non-native speakers were considerably less successful in controlling the acoustical parameters in words such as *confirmation*. They produced a full rather than a reduced vowel in the second syllable which, probably as a consequence, caused them to use inappropriate fundamental frequency, amplitude and length relationships.

Words such as *conquer* were also difficult for non-native speakers, although these words follow the typical initial syllable stress pattern for English nouns. The non-native speakers might have been influenced by the stress rules for prefixed words; clearly, they were not employing the appropriate acoustical correlates of stress.

Although Adams' (1979) study differed from this one in a number of respects, her findings were similar: non-native speakers of English tend to use appropriate acoustic parameters for stressed syllables but have difficulty producing unstressed syllables appropriately.

Although there are obvious limitations because of the single subject per language, two suggestions can be made. Continued investigations of stress patterns on multisyllabic words in citation as well as contextual speech need to be undertaken. Secondly, the instructional value of this research is that effective training of non-native speakers should contain practice not only in the use of stressed and unstressed syllables but in the use of the corresponding full and reduced vowels.

Acknowledgements

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