

PERCEPTION OF STRESSED SYLLABLES IN NATURAL STIMULI:
A CONTRASTIVE ENGLISH—POLISH EXPERIMENTAL STUDY*

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0.1. The concept of stress may be considered from several points of view. From the speaker's point of view it is defined in terms of increased subglottal pressure and it is often maintained that variations in pitch are due to changes in the subglottal pressure. Ladefoged, for example, claims that "... there must be a direct mechanical link between the two" [i.e. between the fundamental frequency changes and the subglottal pressure changes — W.A.] (Ladefoged 1967:34). Ohala's experiments (Ohala 1977) demonstrate that variations in fundamental frequency are independent of the pulmonic system, which is, however, responsible for intensity variations. Thus, these two parameters, i.e. fundamental frequency and intensity, may be investigated independently. The third parameter which the speaker may utilize to mark a stressed syllable is duration.

From the listener's point of view stress is often defined in terms of prominence. Apart from increased fundamental frequency, intensity, and longer duration, prominence of a stressed syllable may also be due to vowel quality since different vowels may have intrinsically different intensities (cf. Lehiste and Peterson 1959). The perception of stressed, i.e. more prominent, syllables may be influenced by phonemic factors, for example, in English aspirated stops appear before stressed vowels while syllabic sonorants occur in reduced unstressed syllables. (cf. Lea 1977). In longer sequences rhythm also plays an important role (cf. Hayes 1984).

0.2. A number of experimental studies using languages such as English (Fry (1958), Morton and Jassem (1965)), French (Rigault (1962)), Czech

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(Janota (1979) and Polish (Jassem, Morton and Steffen-Batóg (1968) show that changes in fundamental frequency are predominant in effecting the listeners' perception of stressed syllables. The other two parameters, i.e. intensity and duration, seem to play a different role in different languages, for example, Jassem, Morton and Steffen-Batóg (1968:306) claim that changes in intensity have a stronger effect for English listeners than for Poles, while variations in duration dominate for Polish subjects.

1.1. EXPERIMENT. In the studies mentioned above the experimenters worked with synthesized speech stimuli. In the study reported in this paper natural speech stimuli were used. The aim of the experiment was to determine the role of fundamental frequency, intensity and duration in the perception of stressed syllables by native speakers of American English and by native speakers of Polish.

1.2. MATERIALS. The materials consisted of 25 nonsense words spoken by two speakers: (a) a native speaker of Polish (KSz) who utilized fundamental frequency, intensity, and duration to mark stressed syllables in a very inconsistent way, and (b) a native speaker of American English (SB) who utilized the three parameters consistently. The forms recorded by the latter were treated as test words.

The list of nonsense words consisted of 15 three syllable words and 10 two syllable words. Each of the five vowels [iueoa] appeared with the same consonant (The list of words is given in the Appendix).

1.3. SUBJECTS. The subjects included both females and males. There were ten Americans and ten Poles. In the two groups there were 'naive' native speakers, some were trained phoneticians, while others had only some phonetic training. The role of this factor was not considered in the present report.

1.4. PROCEDURE. The recordings were made in a sound-treated room. Throughout the entire session a twelve inch subject-to-microphone distance was maintained. The words were printed on a card three times and the vowel to be stressed was marked with an acute accent. Only the second recording was later analysed.

Each of the 25 words was then recorded three times and thus the total number of forms was 150, i.e. 75 forms of each of the two speakers. These forms were recorded in random order with a pause of 6 seconds between each word. The tape prepared in such a way was used in the perception experiment.

The experimenter met his subjects individually or two to four subjects at the same time. The subjects listened to the tape from a tape recorder with two external speakers. They were asked to make judgements as to which syllable was stressed in the words they heard. They were instructed that the aim of the experiment was to test their impression as to which syllable had

been stressed and therefore they should not be afraid that they would make a mistake. On the answer sheet the words were presented in four columns (naturally, without the acute accent) and the subjects were asked to circle the syllable of their choice.

1.5. EQUIPMENT. The recording equipment included an ElectroVoice Model 664 microphone and an Ampex 602 tape recorder. In the perception test a Sony TC-530 tape recorder with two external speakers was used.

1.6. TECHNIQUE. Narrow-band spectrograms were made on a Voice Identification, Inc. Model 700 spectrograph. They were analysed for fundamental frequency, intensity, and duration. The accuracy of the measurements was verified using a Honeywell 1508 A Visicorder.

The tape for the perception experiment was also prepared on the same VII Model 700 spectrograph.

2.1. RESULTS. As expected there were significantly different responses to the words spoken by the native speaker of American English (who was very consistent in utilizing all the three parameters to mark stressed syllables) and to the words spoken by the native speaker of Polish. The number of syllables marked as stressed differing from the speakers' intention is as follows:

	Americans	Poles
SB	13 (1.7%)	20 (2.6%)
KSz	151 (20.1%)	122 (16.3%)

The number of responses different from the intended ones for the speaker SB is too small to draw any conclusions, especially since those responses do not form any pattern. The responses to the forms spoken by the speaker KSz provided the experimenter with interesting data.

2.2. ANALYSIS OF THE RESULTS. Here the analysis of only some of the most typical examples will be presented.

(1)

KSz — speaker's intention	má	fu	ra
Hz	166	166	166
dB	38	32	33
msec.	220	240	300

(2)

KSz — speaker's intention	ke	fi	śi
Hz	200	200	200
dB	29	18	25
msec.	190	190	460

(3)	KSz — speaker's intention		
		má	ku
	Hz	166	200
	dB	33	27
msec.	310	510	

(4)	KSz — speaker's intention		
		sé	pi
	Hz	166	200
	dB	33	26
msec.	290	400	

Since each word was recorded three times, the total number of possible responses was thirty (3×10) in each of the two groups of subjects.

(1) In *máfura*, out of 30 possible responses, American subjects marked the third syllable as stressed in 12 cases, while Polish subjects perceived this syllable as stressed only in 7 cases.

(2) In *kefisi* the first syllable was marked as stressed 17 times by Polish subjects and 9 times by American subjects.

(3) In *máku* only American subjects heard stress placed on the second syllable in 8 cases, while all the Poles marked the first one.

(4) Similarly, in *sépi* the second syllable was marked as stressed 6 times by American subjects and only twice by Polish subjects.

3.1. CONCLUSIONS

(1) When all the three parameters are utilized, i.e. when the stressed syllable has higher fundamental frequency and intensity as well as longer duration, neither native speakers of American English nor native speakers of Polish have any difficulties in perceiving the stressed syllable. It is confirmed by a very small number of responses different from intentions of the speaker SB.

(2) When the syllable which the speaker intended to stress is not significantly higher in fundamental frequency, both American and Polish subjects have difficulties in finding the stressed syllable. The hesitation in responses to the stimuli *máfura* and *kefisi* demonstrates that fundamental frequency is the most important cue in perception of stress.

(3) Responses to the stimuli *máku* and *sépi* show that duration is more effective than intensity for Americans than for Poles.

3.2. SUMMARY. The data in this study corroborate some earlier results, namely, that fundamental frequency is the most important cue in perception of stress (cf. Fry 1958, Morton and Jassem 1965, Jassem, Morton and Steffen-Batóg 1968). They also agree with Fry's (1955) experiment which shows that duration

is a more effective cue than intensity for American listeners. Morton and Jassem (1965) obtained opposite results for British English. In their experiment, however, artificial stimuli were used, and this difference may account for different results obtained in the experiments.

APPENDIX

The list of test words

<i>máfura</i>	<i>sófumo</i>	<i>fúkura</i>	<i>síkemi</i>	<i>férise</i>
<i>rumána</i>	<i>tosóla</i>	<i>lafúku</i>	<i>lisíte</i>	<i>kefémi</i>
<i>sukamá</i>	<i>kumosó</i>	<i>kusafú</i>	<i>kefisi</i>	<i>mikefé</i>
<i>máku</i>	<i>sóma</i>	<i>fúma</i>	<i>sépi</i>	<i>mípe</i>
<i>tumá</i>	<i>tasó</i>	<i>kafú</i>	<i>misé</i>	<i>temí</i>

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