PARAMETERS OF LINGUISTIC STRESS: AN EXPERIMENTAL CONTRASTIVE STUDY

WIESŁAW AWEDYK

Adam Mickiewicz University, Poznań

0.1. From the speaker's point of view stress is often defined in terms of respiratory activity. Ladefoged claims that: "A stressed syllable is produced by pushing more air out of the lungs" (Ladefoged 1975 : 97). Moreover, some phoneticians maintain that pitch variations in speech are due to changes in the subglottal pressure (cf. Berg 1957, Ladefoged 1967, Lieberman 1967).

Ohala (1977) presents convincing experimental data which show that, except for emphatic stress, a strong expiratory pulse does not always accompany the production of stressed syllables. Ohala demonstrates that it is the activity of the laryngeal muscles that causes the variations in fundamental frequency and claims further that "... some of the Ps [=subglottal pressure — W. A.] variations, in fact, are probably dependent upon the action of the larynx itself, not the pulmonic system..." (1977 : 156).

The pulmonic system plays, however, an important role in controlling variations of intensity and therefore these two parameters of stress, i.e., fundamental frequency and intensity, may be investigated independently. The third important factor of stress, namely duration, is independent of either the laryngeal or the pulmonic system.

0.2. Traditionally, languages have been classified into three groups according to which of the parameters: intensity, fundamental frequency or duration, is predominant. Views concerning the classification of English and Polish are not unanimous. Some scholars assert that these languages have expiratory type of stress (cf. Bloomfield (1933 : 110—111) for English, Doroszewski (1963 : 117) for Polish) while others express the opinion that both in English (cf. Bolinger 1958) and Polish (cf. Jassem 1962) stress is characterized, first of all, by variations of fundamental frequency.

A discussion of these works as well as of many other studies is outside the scope of the present article. The fact that there exist such conflicting views poses a question whether it would be possible to investigate experimentally the parameters of stress in English and in Polish in such a way that the results obtained for the two languages could be directly comparable. The experiment reported in this article seems to meet these requirements.*

1.0. EXPERIMENT. This experiment is an attempt to explore the nature of stress in English and in Polish. The underlying hypothesis is that whatever the predominant parameter(s) of stress in English and in Polish is, native speakers of those languages will utilize it in their speech when pronouncing new or foreign words.

1.1. MATERIALS. The material consists of 25 words: 15 three syllable words and 10 two syllable words (The list of words is given in the Appendix). They are nonsense words but the subjects were informed that the words came from an African language.[1] Each of the five vowels [iueoa] appeared with the same consonant in all possible positions in a word.

1.2. SUBJECTS. There were thirteen subjects: (1) six native speakers of American English and (2) seven native speakers of Polish. All the subjects were adult males.

1.3. PROCEDURE. All speech samples were recorded in a sound-treated room. The subjects read the words which were printed on a card three times. The vowel to be stressed was marked with an acute accent, e.g., máfura máfura máfura. It was the second (middle) recording that was later analysed. At no time was any of those words spoken by the experimenter.

The subjects were seated in front of a microphone in such a way that a twelve inch subject-to-microphone distance was maintained throughout the entire recording session. The constant distance was achieved by placing the subject's forehead against the head positioning stand with his mouth twelve inches away from the microphone.

1.4. EQUIPMENT. The equipment included an ElectroVoice Model 664 microphone and an Ampex 602 tape recorder. The recordings were made on a Scotch 176 Audio Recording Tape.

* I would like to express my thanks to all the staff members of the Institute of Advanced Study of the Communication Processes, University of Florida, Gainesville, Florida and especially Prof. William S. Brown, Jr. and Prof. Harry Hollien for their help in the conducting of this experiment.

[1] In fact, the test words sounded like Japanese to some of the subjects.

1.5. TECHNIQUE. Spectrograms were made on a VII (Voice Identification. Inc.) Model 700 spectrograph. Narrow-band spectrograms were analysed for fundamental frequency and intensity.[2] In order to verify accuracy of measurements some recordings, chosen at random, were also analysed on a Honeywell 1508 A Visicorder. The two measurements were almost a perfect match.

In the analysis of intensity an arbitrary base line "0" was posited in the amplitude display.

1.6. RESULTS. The results are presented in Table 1 and Table 2 below.

Table 1. Average fundamental frequency and intensity values for stressed and unstressed syllables produced by American subjects

		SB	JH	DG	BK	RM	HR	Mean
stressed	Hz	159.1	168.4	156.7	136.4	151.2	137.7	152.0
	db	33.5	34.2	35.0	31.7	32.3	33.4	33.0
unstressed	Hz	107.8	145.1	140.0	113.0	129.6	99.9	122.0
	db	24.0	27.3	25.8	23.5	24.5	27.3	25.0
stressed (+)	Hz	51.3	23.3	16.7	23.4	21.6	37.8	30.0
	db	9.5	6.9	9.2	8.2	7.8	6.1	8.0

Table 2. Average fundamental frequency and intensity values for stressed and unstressed syllables produced by Polish subjects

		JCz	MJ	AM	BN	ZP	KS	KSz	Mean
stressed	Hz	196.3	130.4	105.7	148.7	190.8	153.9	186.8	159.0
	db	32.8	28.4	30.2	32.6	31.8	33.4	30.9	31.4
unstressed	Hz	142.0	115.3	87.1	133.1	183.9	103.8	182.9	136.0
	db	26.3	26.8	20.6	28.8	26.4	22.8	28.6	25.8
stressed (+)	Hz	54.3	15.1	18.6	15.6	6.9	50.1	3.9	23.0
	db	6.5	1.6	9.5	3.8	5.4	10.6	2.3	5.6

The data in this experiment demonstrate that the native speakers of American English and Polish utilize the parameters of fundamental frequency and intensity to denote stress in a very similar way. An average stressed syllable produced by American subjects has only 7 Hz higher fundamental frequency and is only 2.4 db. louder than the unstressed syllable than those produced by Polish subjects.

[2] Duration was not considered since length plays a different role in English and in Polish and therefore this parameter is not comparable. In Polish a prolonged articulation of a vowel is associated with emphatic stress (cf. Doroszewski 1963:117) while in English a long syllable may not carry stress, e.g., the first syllable in *urbane*. English and Japanese furnish another example where duration is not a comparable parameter (cf. Taguchi 1981).

These data agree with several previous studies done for English (cf. Lieberman 1960, Brown and McGlone 1974) and for Polish (cf. Jassem 1962).

2.0. CONCLUSIONS. No marked differences were observed between the Americans and the Poles in their use of fundamental frequency and intensity, e.g., the results obtained for the American subject SB are almost identical with those obtained for the Polish subject KS.

The data indirectly corroborate Ohala's assertion (1977 : 156) that variations in fundamental frequency are not controlled by the pulmonic system, e.g., two American subjects, SB and DG, use intensity to mark stressed syllables, while there is a significant difference between the two subjects in the utilization of fundamental frequency (cf. Table 1.).

APPENDIX

The list of test words

máfura	sófumo	fúkura	sfkemi	férise
rumána	tosóla	lafúku	lisíte	kefémi
sukamá	kumosó	kusafú	kefísi	mikefé
máku	sóma	fúma	sépi	mípe
tumá	tasó	kafú	misé	temí

REFERENCES

Berg, J. van den. 1957. "Sub-glottal pressures and vibrations of vocal folds". *Folia Phoniatrica 9*. 65—71.

Bloomfield, L. 1933. *Language*. New York: Holt, Rinehart and Winston.

Bolinger, D. 1958. "A theory of pitch accent in English". *Word 14*. 109—49.

Brown, W. S., Jr. and McGlone, R. E. 1974. "Aerodynamic and acoustic study of stress in sentence productions". *Journal of the Acoustical Society of America 56*. 971—74.

Doroszewski, W. 1963[2]. *Podstawy gramatyki polskiej. Część 1*. Warszawa: PWN.

Hyman, L. M. (ed.). 1977. *Studies in stress and accent*. Southern California Occasional Papers in Linguistics No. 4.

Jassem, W. 1962. *Akcent języka polskiego*. Wrocław: Ossolineum. (Komitet Językoznawczy PAN. Prace Językoznawcze 31).

Ladefoged, P. 1967. *Three areas of experimental phonetics*. London: OUP.

Ladefoged, P. 1975. *A course in phonetics*. New York: Harcourt Brace Jovanovich, Inc.

Lieberman, P. 1960. "Some acoustic correlates of word stress in American English". *Journal of the Acoustical Society of America 32*. 451—54.

Lieberman, P. 1967. *Intonation, perception and language*. Cambridge, Mass.: The M.I.T. Press. (Research Monograph No. 38).

Ohala, J. J. 1977. "The physiology of stress". In Hyman, L. M. (ed.). 1977. 145—68.

Taguchi, M. 1981. *Study of phonetic interference in terms of linguistic stress*. The Institute for Advanced Study of the Communication Processes, University of Florida, unpublished M. A. thesis.