FROM SYLLABLES TO SENTENCES

YAEL FRANK

School of Education
Tel-Aviv University
Tel-Aviv, ISRAEL

Abstract

In this study lexical stress and intonation patterns of 11 normal hearing and 23 hearing-impaired 9-12 year old children were compared. The comparison was done by spectrographic analysis and Visipitch. It appears that the Hearing Impaired in this group succeeded in producing stress on the word level, but failed to make the necessary changes for intonation on the sentence level.

Prosodic features are of great linguistic importance as well as for the perception of naturalness in speech. The term 'naturalness' is of special meaning for the speech of the Hearing-Impaired because the lack or the distortion of some of the prosodic features contributes to the listener's difficulty in understanding the Hearing - Impaired's speech.

Teaching profoundly hearing impaired children the segmental aspects of speech requires much effort on behalf of the therapeutic team, and many children do not acquire enough skills in order to produce prosodic features. One could argue that most prosodic features could be learned without conscious effort, if the children were exposed to speech in their environment (e.g. hearing parents, siblings, schoolmates, etc.) because even many profoundly hearing impaired have enough hearing left in order to detect prosodic features, especially since most prosodic features are found in the frequencies lower than 500 Hz. However, this does not seem to be the case and logopedic and educational personnel have great difficulty in teaching deaf children to acquire those features.

In Israel speech therapists and teachers usually work without exact measurements and are thereby hampered in teaching systematically. And so every therapist "does his best" according to his own inclinations, and the knowledge that he has acquired from the literature in the field. Therefore therapists cannot be sure that their applied strategies are appropriate for the Hebrew-speaking population. This does little to further a consistent methodology in speech therapy.

The following research was done in order to compare some of the physical properties of stress and intonation between hearing and hearing-impaired Hebrew speaking children so we can be able, in the future, to supplement clinical intuition.

The research group consisted of 23 prelingually profoundly hearing impaired children, 9-12 years of age, who had the same oral education from preschool age and were mainstreamed in two classes in a regular school. Their mean hearing loss in the speech frequencies was 99.5 dB in the better ear. In the control group were 11 age-matched normal-hearing children.

The children read aloud 21 sentences (after previously rehearsing them) of varied length, consisting of declaratives, yes-no questions, wh-questions and imperatives. The sentences were composed of words known to be familiar to the children and their general gist was taken from everyday examples of spoken speech between mother and child, or of children between themselves. Before the reading we made sure that the children had learned punctuation. The sentences were hand-printed in bold letters. They were ordered on 3 tables, each new sentence at the beginning of a line.

Recording was done in a quiet room and a pleasant atmosphere (with two children always together in the room to minimalize the effect of new surroundings). Duration of vowels and their fundamental frequency were measured with the help of a Kay-Spectrograph and Visipitch. In order to gather enough information we produced broad- and narrow-band spectrograms and on top of the broad-band a relative amplitude curve. The duration of the vowels was measured between the recognized end or beginning of a consonant (the Hebrew syllable structure is CV or CVC). Fundamental frequency was measured at the vowel midpoint on the Visipitch-trace. The measured Fo was compared with the analog point on the narrow-band spectrogram. In this way, we obtained the principal physical properties of lexical stress [4,5,6].

Duration (measured in msec) of 192 vowels out of 204 was significantly different (according to a t' test) between Hearing and Hearing-Impaired. This means that nearly every word for the Hearing-Impaired needed more time. These results were predictable [2,7,8]. Fo varied significantly in the production of 105 vowels out of the 204 (with higher frequencies for the Hearing-Impaired). This result was also predictable [3].

For lexical stress we computed the relation between stressed and unstressed vowels in duration and in Fo. We took 33 two- and three- syllabic words from the beginning, the middle and the end of the 21 sentences. In contrast to the absolute duration which was longer in nearly all the vowels produced by the Hearing-Impaired, we did not find a statistical difference in the temporal relation unstressed/stressed vowel between the Hearing and the Hearing-Impaired in the words from the beginning and the middle of the sentences. Only in 5 words from the end of sentences did we find a significant difference. It seems that even the profoundly Hearing-Impaired perceive temporal relations.

But the results of the Fo relations between unstressed and stressed vowels showed (according to the t-test) a significant difference ($p<0.01$) in 17 out of the 33 words. This result means that there is a much greater gap in the ratio of Fo than in the ratio of duration.

More evidence of the learning of stress ratios by the Hearing-Impaired was found in a rather curious way. As it happens there were 6 words in the whole set that are mostly found in mother-child discourse in a special stress form [1]. The hearing children changed this special stress form while performing the formal task of reading. Five of the 23 Hearing-Impaired did the same while the others continued with the once-learned stress. This is an interesting phenomenon because it shows that the Hearing-Impaired have acquired a special stress for certain words through their mothers and through frequent use (these were words like gli'da (ice cream), u'ga (cake), shoko'lad (chocolate) and first names like U'ri, Mo'she, Mi'ki). However, only five of them also had the flexibility to change once-acquired patterns.

Continuing our study from syllables to word and then to the sentence level, we arrived at an explanation for the aforementioned facts. When connecting the mean of the measured values of duration and of Fo we see that the hearing children explicitly express intonation of a sentence as a linguistic unit by the variations of Fo, while the Hearing-Impaired string the individual words. They express the learned lexical stress by lengthening and by higher Fo of the stressed vowel. The following declarative sentence will demonstrate this observation.

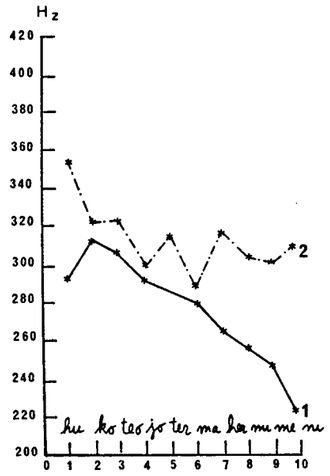

Fig. 1: "Hu ko'tev jo'ter ma'her mi'meni (He writes quicker than me). Group 1, the Hearing, show a declination line for this declarative sentence while group 2, the Hearing Impaired, say each individual word with higher Fo for the stressed vowel.

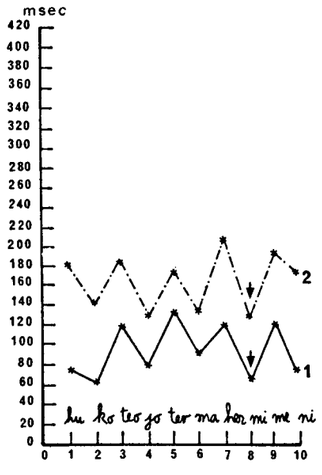

Fig. 2: The measured and connected mean duration values for the same sentence. There is an almost exact parallel between the Hearing (Group 1) and the Hearing-Impaired (Group 2). The Hearing-Impaired have longer absolute values but both groups show the ratio of unstressed/stressed vowel.

Conclusion: In both prosodic features, lexical stress and intonation, we found similar phenemena to the ones mentioned in other languages by other methods of research. It seems that the production of lexical stress is somewhat easier in Hebrew and the hearing-impaired children in this group were able to acquire it. But they are dependent on a learned pattern and therefore not able to divide, like the Hearing, between duration for word stress and variations of Fo for intonation. This could be due to a learning process that did not ask for flexibility but rather emphasized "proper articulation" with the appropriate stress pattern on the word level. Therefore, most of the children were not endowed with the ability to plan a whole sentence and to use pitch according to a plan.

This paper is a portion of a Ph.D. dissertation prepared at the Tel-Aviv University, 1986 and a paper in Tubin J. (ed.). From sign to language; a semiotic view of communication. John Benjamins, Amsterdam, Philadelphia (in press).

References:

1. Bolozky, Sh. (1978) Some aspects of moodern Hebrew phonology in Aronson Berman R., Modern Hebrew Structure. University Publishing Projects, Ltd. Tel-Aviv
2. Bothroyd A., Nickerson R.S., Stevens K.N. (1974). Temporal patterns in the speech of the Deaf. S.A.R.P. #15.
3. Bush, M. (1981). *Vowel Articulation and Laryngeal Control in the Speech of the Deaf.* Doctoral dissertation, M.I.T.
4. Fry, D.B. (1955). Duration and intensity as physical correlates of linguistic stress. *J. Acoust. Soc. Am.* 27, 765-769.
5. Fry, D.B. (1958). Experiments in the perception of stress. *Lang. Speech* 1, 126.
6. Fry, D.B. (1970). Prosodic Phenomena in Malmberg B. (ed.) *Mannual of Phonetics*, North-Holland Publishing Company, Amsterdam, London.
7. Markides, A. (1983) *The Speech of Hearing-Impaired Chioldren.* Manchester University Press.
8. Osberger, M.J., McGarr, N.S. (1982). Speech Production Characteristics of the Hearing Impaired, in Lass, N.J. (ed.) *Speech and Language*, Advances in Basic Research and Practice, Vol. 8. Academic Press Inc., New York.