# OBJECTIVE MEASUREMENTS IN THE SPEECH OF THE HEARING IMPAIRED

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## Introduction:

*"Almost pervasive consequence of the impairment of hearing is the subsequent impairment of the ability to produce intelligible speech".*

*(Monsen, 1976a)*

Several researchers (Voelker, 1938; Hudgins and Numbers 1942; Boone, 1966; Nober, 1967; Colton and Cooker, 1968; Markides, 1970; Smith 1975; Geffner, 1980; ) have attempted to describe the characteristics of speech of the hearing impaired. The characteristics include articulation errors, high pitched voice, improper intonation, improper rhythm, slow rate and nasality.

Several researchers (Calvert, 1962; Angelocci et.al., 1964; Monsen, 1974, 1976a, 1976b, 1976c, 1978, 1979; Gilbert and Campbell, 1978; Rothman, 1976; Whitehead and Jones, 1976, 1978; and Leeper et. al., 1980) have recognized the need for describing the speech of the hearing impaired individuals using objective measures like voice onset time, vowel duration, formant frequencies, consonant duration fundamental frequency, transitional patterns, oral and nasal airflow, shimmer and jitter. Describing the speech of the hearing impaired objectively not only has the advantage of an objective measurement but it also sheds some light on the probable reasons for the poor intelligibility, which in turn may help in developing effective therapeutic procedures. Many of the speech parameters which are relate to speech intelligibility are language specific. The present study, the first of its kind of India, compared matched groups of 30 normally hearing and 30 hearing impaired individuals. The following seven parameters were studied using lists of words in Kannada, an Indian language.

1 ) Phonological space

2) Vowel Duration

3) Voice onset time

A) Consonant duration

5) Diadochokinetic Rate

6) Breath duration

7) Fundamental frequency

## Methodology

Subjects read the 5 lists of 34 disyllabic words. The disyllabic words were formed by combing eleven consonants ([p], [b], [t], 'id], [k], [g], [c], [j], [1], [n], and ls]) and three vowels ([a], [i] and [u]). The eleven consonants were selected to provide a representative sampling for voiced-voiceless cognate pairs, varying manners of articulation and different places of articulation. The three vowels chosen because they were identified by a pilot study as extreme points of vowel space. In addition to this the subjects were required to utter [pa, ta, ka] as fast as they could and phonate the vowel [a] for as long a time as they could. Sound spectrograph (Voice Identification 700 series} was used for acoustic analysis. Wide band bar and wide band section spectrograms were made for the measurement of voice onset times, vowel durations, consonant durations, formant frequencies and diadochokinetic rates. Fundamental frequency was noted from the digital display of the digipitch and breath durations were recorded using a stop watch.

## Results:

The following were the findings:

1) 1 he hearing impaired speakers on the average had a reduced frequency

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range for F1 and a severely reduced frequency range for F2 when compared to the normally hearing speakers.

2) On the average the duration of vowel the [a] was longer when followed by a voiced consonant than when followed by a voiceless consonant in both the groups of subjects. However, in both the groups the difference was less than the JND for duration.

3) In both the groups vowel [a] was the longest in duration when followed by a nasal within the voiced sounds category and when followed by fricative [s] within the voiceless sound category.

4) The duration of the vowel [a:] in the medial position was longer in the speech of the hearing impaired than in the speech of the normally hearing speakers.

5) In normally hearing speakers the mean duration of the vowels [a], [i], and [u] in the final position, that is, preceded by different consonants were around 200 m.sec, 195 m.sec., and 285 m.sec respectively. In the hearing impaired speakers [i], and [u] tended to be longer than in normal speakers and the vowel [a] tended to be either longer or shorter when compared to the length of the vowel [a] in normal speakers.

6) Hearing impaired speakers showed a greater variation in vowel durations than normally hearing speakers.

7) In the normally hearing speakers vowel [a] in the final position was longer than vowels [i] and [u] whereas in the hearing impaired speakers, vowel [a] was shorter than vowels [i] and [u].

8) There was a vowel lengthening phenomenon in Kannada language.

9) Both the groups of subjects did not show any consistent changes in the durations of the vowels depending upon the preceding consonants.

10) Both normally hearing and hearing impaired speakers had positive VOT values for voiceless stops. However, VOT values for the hearing impaired speakers were shorter.

11) Normally hearing speakers showed negative VOT values for voiced stops, while in a majority of the hearing impaired speakers negative VOTs were absent.

12) Mean VOT values produced by both the groups increased as the place of articulation moved backward in the oral cavity.

13) In both the groups of subjects durations of consonants were longer in vowels [i] and [u] environments than in the vowel [a] environment. This finding does not support Schwartz's (1969) hypothesis of differential effects of vowel environment on consonant duration.

14) In both the groups velar sounds tended to be longer than bilabial consonants in both the voiced and the voiceless categories.

15) In the speech of the normally hearing subjects voiceless consonants were significantly longer than the voiced consonants. Whereas, in the speech of the hearing impaired the durational difference between voiced and voiceless consonants was considerably reduced.

16) In both the groups of subjects the lateral sound [1] among the voiced sounds and the fricative [s] among the voiceless sounds were the shortest in duration.

17) In the speech of the normally hearing the affricates [c] and [j] were the longest, whereas, in the speech of the hearing impaired [t] and [d] were the longest in voiceless and voiced categories of sounds respectively.

18) Durations of all the consonants were longer in the speech of the hearing impaired than in the normally hearing speakers.

19) Hearing impaired speakers showed a greater variations in controlling the length of all the consonants than normally hearing speakers.

20) The hearing impaired speakers had a reduced rate of diadochokinetic rate when compared to the normally hearing speakers.

21 ) Normally hearing speakers had a longer breath duration.

22) Fundamental frequency was higher, on the average in the speech of the hearing impaired. However, a majority of the hearing impaired speakers fell within the normal range.

Conclusions:

The data from the normally hearing subjects show that the speech parameters are language specific, that is, parameters are different in quality and quantity in different languages. For example, in the English language voiced stops have shorter positive VOT values and voiceless stops have longer positive VOT values. Whereas in the Kannada language voiced stops have negative VOT values and voiceless stops have positive VOT values., Similarly, in English the vowels [i] , [a] and [o] form the extreme points of vowel space (Monsen, 1976c) whereas in Kannada the vowels [i] [a] and [u] form the extreme points of vowel space.

However, we may see that certain speech parameters to behave similarly in different languages. For example, vowel lengthening phenomenon which is seen in the English language is also seen in the Kannada language. These observations emphasize the need for studying the different parameters of speech in different languages. The present study provides normative data for the parameters studied for the Kannada language.

The results of this research indicate that the hearing impaired individuals differ from normals in certain temporal and frequency characteristics of their speech. Further, a greater variance was seen in the hearing impaired individuals than in the normally hearing groups, that is, the hearing impaired speakers not only behaved differently from normals but they also were differert from each other. Naturally, these deviant features in the speech of the hearing impaired need to be modified to improve and enhance speech intelligibility. From the observations made on the spectrograms the study has recommended the use of sound spectrograph for therapy purposes. However, the extent to which these deviant features may be modified in order to improve speech intelligibility using a visual feedback system, like spectrograph, visible speech patterns and/or biofeedback system is of interest for future research.

Research may be also focussed on to assess the effect of different types of oral training on the speech production by the hearing impaired.

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