Acoustic Analysis of the Speech of the Hearing-impaired*

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The speech- of the deaf differs from that of normals in all regards.

In all the studies of the speech of the hearing-impaired, attention is drawn to the fact that, to a greater or lesser degree, the hearing-impaired individuals do not produce speech as well as those who hear.

To bring the speech of the hearing-impaired closer to the normals, a clear understanding of their speech is a must, which should be done by objective measurements. This would help in describing objectively the speech of the hearing-impaired and also in deciding the selection of the parameters for therapy.

But a review of literature shows studies based on subjective evaluations and very few studies on the objective measurements of the speech of hearing-impaired.

Hence the present investigation was undertaken in order to study certain acoustic parameters, recommended by Hirano (1981) and the norms of which have been given for the Indian population namely :

1. Maximum phonation duration of vowels.
2. Fundamental frequency of phonation.
3. Frequency and intensity range in phonation.
4. Speaking fundamental frequency.
5. Frequency and intensity range in speech.
6. Rise and fall time of phonation.
7. Intensities at harmonics.
8. Vowel duration.

These parameters were studied in a sample of 53 school-going hearing-impaired children, 31 males and 22 females, ranging in age from 10-20 years. All these subjects had hearing-loss, with a minimum of 60 dB or above, in the better ear. They had no respiratory problem, no observable deformities of nasal, oral or pharyngeal caviiies and no mental retarda'ion.

The collection of sample consisted of recording the maximum duration of phonation for three vowels [a], [i] and [u 1 and the repetition of three Kannada sentences namely " idu papu", " idu koti" and "idu kempu banna". Each subject was given 3 trials. One of these samples from each of the three trials was used for analysis.

The phonation duration of vowels was measured using a stop-watch, the longest was considered as the maximum duration of phonation.

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This sample was then fed to the Pitch Analyzer (PM-100) to obtain the fundamental frequency of phonation, frequency and intensity range in phonation and the rise and fall time of phonation. The three stimulus sentences were then fed to the Pitch Analyzer and the speaking fundamental frequency, frequency range in speech and intensity range in speech were obtained for each subject.

To measure the vowel duration and the intensities at harmonics below and above 1 K (a-ratio) the word "idu" was fed to the High Resolution Signal Analyzer. The duration of the vowel [i] and the a-rat io was measured for all the subjects.

The data thus obtained were subjected to statistical analysis, in order to determine the mean standard deviation and the significance of difference.

Conclusions

After the statistical treatment, the following conclusions were drawn :

I. ***Maximum Phonation Duration***

(1) A significant difference between the age groups studied, both in males and females showing an increase in MPD with increase in age was noted.

(2) No significant difference was observed in MPD between males and females in 10-15 years group. These parameters showed a similar frequency as in normals.

(3) Of the three vowels studied MPD of **[** a **]** was found to be greatest followed by [i] and finally [u]. This unlike in normals had showed maximum MPD for [i] followed by [u] and then [a).

II. ***Fundamental Frequency of Phonation***

(1) A significant difference in F_o for the two groups was seen between males and females.

(2) A significant difference between the two sexes was also seen.

(3) The F_o for vowel [a] was lowest when compared with [i] and [u], which varied in different age groups for both males and females.

III. ***Frequency Range in Phonation***

(1) A significant difference was seen between males and females and also between the two age groups as a function of age.

(2) Both males and females at different age groups showed greater frequency range when compared with normals, also showed a wide individual variation.

IV. ***Intensity Range in Phonation***

(1) A significant difference was seen between males and females and also between the two age groups as a function of age, except for vowel [i] where the males showed no difference between the two age groups.

(2) A large individual variation was seen in intensity range as compared with the normals.

V. ***Rise and Fall Time in Phonation***

(1) A significant difference was seen between males and females and also between the two age groups as a function of age.

(2) Compared with normals the hearing-impaired population showed a lower rise and fall time, indicating an abrupt initiation and termination of phonation.

VI. ***Speaking Fundamental Frequency***

(1) A significant difference was seen between males and females and also between the two age groups as a function of age.

(2) Compared with the normals, the hearing impaired in general showed a higher SFF.

VII. ***Frequency Range in Speech***

(1) A significant difference was seen between males and females and also between the two age groups as a function of age.

(2) The hearing-impaired showed almost double the frequency range as compared with normals, again with large individual variations.

VIII. ***Intensity Range in Speech***

(1) A significant difference was seen between males and females and also between the two age groups as a function of age.

(2) The hearing-impaired females showed a higher intensity range than normals but in males it was similar to normals. But both showed a large variation when compared with normals.

IX. ***a-Pammeter***

(1) A significant difference was seen between males and females and also between the two age groups as a function of age.

(2) In comparison with normals the a-ratio value in hearing-impaired indicated a slightly lower value, which may be indicative of a change in the quality.

X. ***Vowel Duration***

(1) A significant difference between the males and females in the two age groups was seen.

(2) No significant difference was seen in females as a function of age in vowel duration, which could be due to continuation, in later age of using a higher F_o.

(3) A significant difference was seen between males as a function of age.

(4) The hearing-impaired showed a significantly higher vowel duration, as compared with normals.

It is clear from the present study that the speech of the hearing-impaired differed from that of the normals in the acoustic characteristics mentioned above.

In addition to the deviations from normals, there were large individual variations among the hearing-impaired individuals.

To improve the speech of the hearing-impaired, these parameters may be worked upon through the use of different feedbacks, thus improving their intelligibility of speech.

Recommendations

(1) The study may be carried out with a larger sample and also for other age groups.

(2) The analysis could be extended to other vowels and larger speech samples.

(3) A study to observe the effect of modifying these deviant features on the overall speech intelligibility of the hearing-impaired would be interesting.