QUALITY JUDGEMENT OF INDIAN HEARING AIDS USING HEARING AID TRANSDUCED SPEECH DISCRIMINATION

G. RAMANI

Abstract

One hundred subjects with normal hearing and normal discrimination were tested using pure tones and phonetically balanced monosyllables. Later, to study the effect of hearing aid distortion in speech, five popular Indian hearing aids were chosen. Using controlled system four equivalent list of monosyllables were recorded through these hearing aids on a high fidelity tape recorder. It was then administered to the above subjects through the audiometer to find discrimination score. The difference between two discrimination scores was taken to rank the hearing aids in terms of their fidelity.

In the electro-acoustic evaluation of a hearing aid, the major factors that are responsible for speech intelligibility are determined. They are the frequency response, harmonic distortion, intermodulation distortion, signal to noise ratio, etc. It is essential to select a hearing aid with low distortion, ample gain, maximum power output and wide frequency response characteristics to maintain maximum clarity of speech. Harris (1961), Bode (1963), Jerger (1966) Kastein (1967) and Lotterman (1967) have supplied evidence of decrease in speech intelligibility when excessive distortion products are present in low fidelity circuitry. Olsen (1967) reported on the importance of the width of frequency response relating to hearing aid speech intelligibility. There is increasing evidence to emphasize the importance of distortion products as being detrimental to both objective and subjective aided performance, particularly when such performance is evaluated in the presence of background noise or competing message.

Jerger, Speaks and Malmquist (1966) found both subjective quality judgements and intelligibility to be related to the degree of harmonic distortion present in hearing aids. Using tape recorded speech material and competing continuous discourse which had been transduced through three hearing aids with harmonic distortion (the average of 500, 700 and 900 CPS) ranging from 4% to 16% they found the performance of normal hearing and hearing impaired listeners to be universely proportional to harmonic distortion. Thus, there are many studies ndicating the effect of distortion on speech intelligibility.

Jerger (1971) reported that speech will be affected if there are distortions. He suggested to use hearing aid transduced speech for discrimination so as to select the best hearing aid. In a study, Pandalay (1970) reported that Indian hearing aids differ very much in terms of distortion characteristics. It produces more than 5% distortion which can therefore affect speech.

The aim of the present study is therefore to evaluate the efficiency of Indian hearing aids to reproduce speech in quiet and in noise. Since only very few studies have been made on

Indian hearing aids and practically nothing on their speech reproduction ability, the present study was undertaken.

The purpose of the present study was to evaluate the efficieney and fidelity of various Indian hearing aids using hearing aid transduced monosyllables for discrimination and to test the following two hypotheses :

1 There is no significant difference in performance between different Indian hearing aids in speech reproduction and

2 The presence of noise does not significantly affect the performance of these hearing aids.

METHODOLOGY

The present study in brief included the following five steps :

1 Establishing pure tone aids conduction thresholds.

2 Establishing conventional SRT and speech discrimination.

3 Recording the PB list through various Indian hearing aids.

4 Testing the discrimination using the hearing aid processed speech : and

5 Testing the speech discrimination of hearing aid processed speech in presence of a competing noise.

Subjects

100 Normal subjects in an age range of 17 to34 years were selected. All were otologically normal. All had pure tone thresholds below 20 dB through 250 Hz to 8000 Hz. All the subjects were graduates. The subjects were divided into five groups to test the performance of each of the five hearing aids selected for the study. All the subjects had SRT which was within 7dB of their pure tone average. The mean PTA of the subjects was 11dB and the mean SRT was 10 dB. All the subjects had speech discrimination in a range of 92% to 100% at an average intensity 35 dB above SRT. The average discrimination score was 99.6%.

Preparation of PB word lists

The discrimination word lists used in the present study were prepared and standardized and they were (1972) based on PAL PB word lists. However, as a safety measure the list of words were further given to 100 subjects to select 100 familiar words to prepare four equivalent lists, namely List 1, List 2, List 3 and List 4 having 25 words each. These lists were used to measure the discrimination of all the experimental subjects throughout the study. The SRT and speech discrimination tests were administered using recorded speech on a Sony Tape recorder. As discrimination was found to be 100 per cent at 35 dB above SRT it was taken as the level for presentation of word lists throughout the study.

All the tests were administered in the sound treated rooms.

Experiment

Five Indian hearing aids namely Oticon, extra super, Danavox 6471, Danavox AVC and Rionet were selected for the purpose of the study. As they were easily accessible to the author. These hearing aids were tested for their electro acoustic characterstics using a B & K hearing aid test box (type 4217), a 2 CC coupler, a condensor microphone (B & K type 4144) and frequency analyser (B & K 2107). Measurement of gain characterstics of the hearing aids helped to set the aids at half of their average gain at speech frequencies. This level was arbitrarily selected to avoid excessive distortion due to overloading. The recorded word lists from the tape recorder were then presented to the hearing aid test box and the input to the hearing aid was kept at 60 dB SPL. The receiver of the aid was connected to a condensor microphone using a 2 CC coupler. Through a measuring amplifier (B & K type 2607) the output was recorded on a Sony tape recorder. All the four lists were transduced through each hearing aid. All the recordings were made in the sound treated room.

The recorded hearing aid transduced speech was then presented through Beltone 15CX clinical audiometer using TDH 39 earphones with MX 41 cushion. 20 subjects were tested for each hearing aid. Only one list was presented to each subject so as to avoid the question of any familiarity. The presentation of the monosyllables was kept constant at 35 dB above SRT. Since, the hearing aids are usually worn in noisy environment, it was decided to check the effects of white noise on the hearing aid transduced words. For this, three signal-to-noise ratios, viz., 0 dB S/N, -5 dB S/N and -10 dB S/N were selected. A Total of 25 subjects were selected for this study were asked to repeat the words in the presence of noise as much as they could.

Results and Discussions

To test the null-hypothesis, that 'there is no significant performance among different hearing aids', the 'two way classification with multiple but equal number of observation per cell' method was used. F (observed) value of 94.08 was greater than F (table) value of 3.56 at .05 level of significance and of 2.49 at 0.01 level of significance to indicate that there was a difference in performance among hearing aids.

To find whether there was a significant difference in performance or not, the 'T' test was used. The results indicated a significant difference in performance between two pairs of hearings aids, i.e., between Oticon extra super, and Rionet and Danavox AVC and Rionet hearing aids.

Indian hearing aids and practically nothing on their speech reproduction ability, the present study was undertaken.

The purpose of the present study was to evaluate the efficieney and fidelity of various Indian hearing aids using hearing aid transduced monosyllables for discrimination and to test the following two hypotheses :

1 There is no significant difference in performance between different Indian hearing aids in speech reproduction and

2 The presence of noise does not significantly affect the performance of these hearing aids.

METHODOLOGY

The present study in brief included the following five steps :

1 Establishing pure tone aids conduction thresholds.

2 Establishing conventional SRT and speech discrimination.

3 Recording the PB list through various Indian hearing aids.

4 Testing the discrimination using the hearing aid processed speech : and

5 Testing the speech discrimination of hearing aid processed speech in presence of a competing noise.

Subjects

100 Normal subjects in an age range of 17 to34 years were selected. All were otologically normal. All had pure tone thresholds below 20 dB through 250 Hz to 8000 Hz. All the subjects were graduates. The subjects were divided into five groups to test the performance of each of the five hearing aids selected for the study. All the subjects had SRT which was within 7dB of their pure tone average. The mean PTA of the subjects was 11dB and the mean SRT was 10 dB. All the subjects had speech discrimination in a range of 92% to 100% at an average intensity 35 dB above SRT. The average discrimination score was 99.6%.

Preparation of PB word lists

The discrimination word lists used in the present study were prepared and standardized and they were (1972) based on PAL PB word lists. However, as a safety measure the list of words were further given to 100 subjects to select 100 familiar words to prepare four equivalent lists, namely List 1, List 2, List 3 and List 4 having 25 words each. These lists were used to measure the discrimination of all the experimental subjects throughout the study. The SRT and speech discrimination tests were administered using recorded speech on a Sony Tape recorder. As discrimination was found to be 100 per cent at 35 dB above SRT it was taken as the level for presentation of word lists throughout the study.

All the tests were administered in the sound treated rooms.

Experiment

Five Indian hearing aids namely Oticon, extra super, Danavox 6471, Danavox AVC and Rionet were selected for the purpose of the study. As they were easily accessible to the author. These hearing aids were tested for their electro acoustic characterstics using a B & K hearing aid test box (type 4217), a 2 CC coupler, a condensor microphone (B & K type 4144) and frequency analyser (B & K 2107). Measurement of gain characterstics of the hearing aids helped to set the aids at half of their average gain at speech frequencies. This level was arbitrarily selected to avoid excessive distortion due to overloading. The recorded word lists from the tape recorder were then presented to the hearing aid test box and the input to the hearing aid was kept at 60 dB SPL. The receiver of the aid was connected to a condensor microphone using a 2 CC coupler. Through a measuring amplifier (B & K type 2607) the output was recorded on a Sony tape recorder. All the four lists were transduced through each hearing aid. All the recordings were made in the sound treated room.

The recorded hearing aid transduced speech was then presented through Beltone 15CX clinical audiometer using TDH 39 earphones with MX 41 cushion. 20 subjects were tested for each hearing aid. Only one list was presented to each subject so as to avoid the question of any familiarity. The presentation of the monosyllables was kept constant at 35 dB above SRT. Since, the hearing aids are usually worn in noisy environment, it was decided to check the effects of white noise on the hearing aid transduced words. For this, three signal-to-noise ratios, viz., 0 dB S/N, -5 dB S/N and -10 dB S/N were selected. A Total of 25 subjects were selected for this study were asked to repeat the words in the presence of noise as much as they could.

Results and Discussions

To test the null-hypothesis, that 'there is no significant performance among different hearing aids', the 'two way classification with multiple but equal number of observation per cell' method was used. F (observed) value of 94.08 was greater than F (table) value of 3.56 at .05 level of significance and of 2.49 at 0.01 level of significance to indicate that there was a difference in performance among hearing aids.

To find whether there was a significant difference in performance or not, the 'T' test was used. The results indicated a significant difference in performance between two pairs of hearings aids, i.e., between Oticon extra super, and Rionet and Danavox AVC and Rionet hearing aids.

The mean performance of these hearing aids was used to rank order them as follows :

Sl. No.	Rank	Mean performance	Hearing Aid.
1	A	84.70	Oticon extra super
2	B	77.20	Danavox AVC
3	C	75.40	Oticon Super
4	D	74.40	Danavox 6471
5	E	45.20	Rionet

In order to find out whether the presence of noise significantly affected the performance of these hearing aids or not, the Friedonann's test was used. At 0 dB S/W, F (observed value of 15.75 was greater than F (table) value of 9.48 at 0.05 level of significance. At -5dB S/N F (observed) value of 13.98 was greater than F (table) value of 9.48 at 0.05 level of significance. At –10 S/N, F (observed) value of 14.12 was greater than the F (table) value of 9.48 at 0.05 level of significance. The results indicated a significant difference in performances of hearing aids when different levels of noise were administered.

In order to find out whether there is a difference among hearing aids at each level the Mann Whitney test and Kriskal-Wallis one way analysis test were employed. The five hearing aids have been listed in the decreasing order of their performance.

Sl. No,	Hearing aid	At OdB S/N mean performance	Rank	At -5dB S/N mean performance	Rank	At -10 dB S/N mean performance	Rank
1	Oticon extra super	50.4	A	39.2	A	29.6	A
2	Danavox AVC	45.6	B	36.0	B	24.0	B
3	Oticon Super	44.0	C	33.6	C	23.5	C
4	Danavox 6471	40.8	D	30.4	D	21.6	D
5	Rionet	32.0	E	24.8	E	18.5	E

Results of the present study, show that it is possible to qualify the hearing aids through behavioral tests and the performance difference, which was consistent could be measured. The results are in consonance with Jeffers and Smith's study (1964). Oticon extra super hearing aid was found to be superior in performance to other hearing aids used probably because of its greater fidelity and lower internal noise, and the poor performance on Rionet hearing aid might be due to poor fidelity, greater distortion and greater internal noise. This shows that the physical differences among hearing aids can be reflected in behavioral tests.

n the present study, there was a reduction in discrimination under aided conditions than without it. This is in consonance with the study of Tillmean, Carhart, Wayne and Olsen (1970).

The results of the present study, led to formulate the following conclusions.

1 Intelligibility of speech through hearing aids can be impaired in a background of competing message.

2 The extent of reduction in intelligibility depends on signal to noise ratio, and

3 At the same signal to noise ratio, the performance of different hearing aids would be different.

The above results have also been supported by the findings of Bleeker and Hinzing (1953), Carhart (1946) Davis et al. (1946), Schubert (1960), and Jerger (1971).

REFERENCES

Harris: et al, The relationship between speech intelligibility and elctroacoustic characteristics of low fidelity circuitary - JAR 1, 1961, p. 357.

Jerger: Comparison of some intelligibility test in Evaluation of Hearing Aid performance. JSHR 9, 1966, p. 253.

Jerger: Speaks, Carolyn & Malmquist : Hearing aid performance and hearing aid selection. JSHR 9, 1966, p. 136.

Lotterman: Influence of Gain Control Relation and Nonlinear Distortion in Hearing aids JSHR 10, 1967 p. 593.

Pandalay, SPC et al: Performance Characteristics of Indian Hearing Aids - AIISH Journal, p. 108 V. III, 1972.

Tillman: Carhart, Wayne and Olsen : Hearing Aid Efficiency in a competing Speech Situation, JSHR 13, 1970, p. 789.