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The relationship among perceived hearing handicap, pure-tone average, and articulation index for an elderly population

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THE RELATIONSHIP AMONG PERCEIVED HEARING HANDICAP, PURE-TONE AVERAGE, AND ARTICULATION INDEX FOR AN ELDERLY POPULATION

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ABSTRACT

This study was conducted to determine the relationship between a self-perceived hearing handicap index, pure-tone average and Articulation Index scores in an elderly population. The purpose of the study was to provide pass/fail guidelines for a screening procedure based on the relationship between self-percieved hearing handicap and the Articulation Index (AI). The results of this study indicate that pure-tone average and Articulation Index scores correlate equally well with hearing handicap scores and that some degree of self-perceived hearing handicap would be expected when the Articulation Index is less than 75%. For an individual case, however, the self-reported hearing handicap actually reported may not be in agreement with the severity of the hearing loss.

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Hearing impairment is defined as "a change for the worse in either structure or function outside the range of normal and is due to any anatomic or functional abnormality that produces hearing loss." (AAO-ACO, 1979; p2055) The hearing impairment can be measured using standard audiometric techniques such as pure-tone thresholds, speech reception thresholds and speech discrimination tests. Hearing handicap is defined as "the disadvantage imposed by an impairment, sufficient to affect a person's efficiency in the activities of daily living." (AAO-ACO,1979; p2055) A number of scales have been developed to assess the hearing handicap, which rely on the subjective reports of the hearing impaired person (High, Fairbanks and Glorig, 1964; Noble and Atherley, 1972; Ventry and Weinstein, 1982).

Subjective reports of hearing handicap are an important addition to audiometric data. Several specific applications of perceived hearing handicap scales have been reported. Self reported hearing handicap has been shown to provide useful information for the selection of hearing aid candidates and in predicting successful use and benefit from the hearing aid (Rosen, 1978; Schow and Nerbonne, 1982; Ross, 1972). Self reported hearing hadicap scores have also been shown to be useful as a hearing screening procedure (Ventry and Weinstein, 1983; Weinstein, 1986).

Although descriptive information about the consequences of hearing loss is important and useful information for the audiologist, at some time thresholds and other audiometric data must be obtained before recommendations pertaining to treatment or rehabilitation can be made. Hearing handicap, by the definitions previously cited, will occur only if a hearing impairment is present. If a correspondence between the handicap and impairment can not be demonstrated, then the validity of one measurement or the other must be questioned or other factors must be examined to explain the discrepency. In some cases, the reported hearing handicap may underestimate the true hearing handicap. Rezen and Hausman (1985) and Giolis (1982) describe stages of adjustment to the loss of hearing. A person in the denial or projection stage described by Rezen and Hausman would be expected to underestimate his true hearing handicap when questioned. A report by Newman and Weinstein (1985), however, would indicate that in many cases the person experiencing the loss of hearing would rate the handicap higher than a spouse. This may indicate a tendancy in some cases for the hearing impaired person to exaggerate the associated hearing handicap. Again, this would indicate a need for the perceived hearing handicap to be confirmed by measurements of the hearing impairment.

All audiometric data does not correlate equally well with self perceived hearing handicap. Several studies have reported on the relationships among pure-tone audiometric data, speech reception thresholds, measures of speech discrimination and self-perceived hearing handicap scales (Speaks, Jerger, and Trammel, 1970; Berkowitz, and Hochberg, 1971; McCartney, Maurer, and Sorenson, 1976). These studies indicate the pure-tone average and the speech reception threshold for the better ear to be more highly correlated with hearing handicap indicies (correlation coefficients in the range of 0.60-0.70), than maximum speech discrimination scores for the better ear (correlation coefficients of approximately 0.35). These studies also indicate that the perceived hearing handicap is determined mainly by the hearing sensitivity at the better ear. Correlation coefficients for the poorer ear have been shown to be lower than for the better ear.

This study was conducted to determine the relationship between self-perceived hearing handicap, pure-tone average and Articulation Index scores in an elderly population. The purpose of the study was to provide pass-fail guidelines based on the relationship between hearing handicap and Articulation Index (AI) for a hearing screening program. A limitation of using pure-tone averages as criteria for pass or fail of a hearing screening test is that the frequency ranges most affected in cases of presbycusis (Giolas, 1982) are not considered in the calculation of the pure-tone average. Some advantage of using the AI is that a wide range of frequencies are considered in a weighted manner and a monotonic relationship between AI and speech discrimination ability have been demonstrated (Kryter, 1962).

METHODS

SUBJECTS

There were 25 male and 15 female subjects with an age range from 62 to 90 years selected for participation in this study. The sample consisted of individuals who had hearing tests at an adult hearing screening program provided by Central Institute for the Deaf. The mean three frequency (500, 1000 and 2000 Hz) pure-tone average of the better ear was 28.41 dB (HL), with a range from 6.67 to 60.00 dB (HL). All of the subjects were from the metropolitan St. Louis area. All subjects lived by themselves or with a spouse in an apartment or single family home. None of the subjects had used hearing aids.

PROCEDURE

For each subject, hearing thresholds were measured for pure-tones at octave frequencies between 250 and 8000 Hz. Threshold was defined as the sound pressure level at which a pure-tone was detectable in 50% of the presentations. There was a minimum of three positive responses at threshold. The test environment was sufficiently quiet to measure thresholds under earphones at a hearing level of 0 dB (HL) (ANSI, S3.1-1977). The audiometer (Grason-Stadler, model 1715) was calibrated to ANSI standards (ANSI, S3.2-1969). Prior to obtaining pure-tone thresholds, the Hearing Handicap Inventory for the Elderly-Screening (HHIE-S) was administered (Weinstein and Ventry, 1983). This short version of the HHIE was developed to screen for self-assessed hearing handicap. The reason the HHIE-S was selected for use is that it was designed for and standardized on elderly people. The 25-item clinical version (Ventry and Weinstein, 1982), was reduced to a ten-item screening tool that includes five social/situational items and five emotional response items. The items were selected by Weinstein and Ventry in such a way as to insure that the short form was of comparable reliability to the long form. Scores on the HHIE-S can range from 0-40; a YES response is assigned four points, a NO response is assigned zero points, and a SOMETIMES response is assigned two points. Weinstein and Ventry (1983) divided HHIE-S scores into three catagories according to the severity of the handicap: 0 to 8 (no perceived handicap), 10 to 22 (mild to moderate handicap), and 24 to 40 (significant handicap).

For each subject an AI was calculated from the pure-tone threshold data. The AI was computed using a computer program (Skinner, Pascoe, Miller and Popelka, 1982). This program computes an Articulation Index based on the American National Standard Methods for the Calculation of the Articulation Index (ANSI 3.5, 1969), but the bands and weightings have been adjusted to comform to standard audiometric frequencies (Popelka and Mason, 1987). The computer program also multiplies the AI by 100 and expresses the index as a percent score.

RESULTS

The forty subject's average values for the various measurements calculated in this study are given in Table 1. The data shows the pure-tone average of the poorer ear (PTA-PE) to be 8.4 dB higher (decreased sensitivity) than the pure-tone average of the better ear (PTA-BE). The table also shows a corresponding lower AI score for poorer ears. As PTA or the hearing impairment becomes greater, the AI score becomes lower. Compared to the average score for better ears, the AI for the poorer ear was reduced 13.7%. According to Weinstein and Ventry's classification system (1983), the average score of 18.4 on the HHIE-S for this group of subjects (18.4) would indicate that the individuals in this group, on the average, perceived themselves to be mild to moderatly handicapped due to hearing loss.

Pearson-product moment correlations were calculated among HHIE-S, PTA-BE, PTA-PE, AI-BE and AI-PE (Winer, 1971). The correlation coefficients are shown in Table 2. The correlations are all statistically significant at a 0.5 level for significance and 38 degrees of freedom, but somewhat lower than reported in previous studies for PTA and hearing handicap. The difference between correlations of PTA-BE and AI-BE with HHIE-S scores were small. There is also little difference between the coefficients for better and poorer ears. The data also indicates that the scores on the HHIE-S are significantly correlated with high frequency average (2000 and 4000 Hz) and low frequency averages (250 and 500 Hz), but these correlation coefficients tend to be less than those seen for AI or the average thresholds at 500, 1000 and 2000 Hz.

DISCUSSION

The correlations between HHIE-S and audiometric data were statistically significant but somewhat lower than reported previously for pure-tone average and hearing handicap indices (Speaks, Jerger and Trammel, 1970; McCartney, Maurer, and Sorenson, 1976; Ventry and Weinstein, 1982). The lower correlation coefficients may be a result of the age of the population under study. This study focused attention on the elderly population. Berkowitz and Hochberg (1971) reported that as age increases correlations between pure-tone average and self-perceived hearing handicap decrease. Corbin, Reed, Nobbs, Eastwood and Eastwood (1984) reported that within a population in nursing homes for the elderly, self assessed hearing handicap was not consistant with the type and degree of hearing loss defined audiometrically.

Another reason for the relatively low correlations between HHIE-S and AI or PTA is that our data would indicate that these relationships are not linear. As can be seen from Table 3, the correlation coefficient (r) improved when a nonlinear model was used relative to when a linear model was used. For our sample, the correlation coefficients for AI-BE and HHIE-S scores increased from .518 when the linear model was used to .637 when a nonlinear model was used. This would indicate that 26.9% of the varience in HHIE-S scores can be explained by its linear relationship with AI, but more than 40% can be explained by its curvilinear relationship with AI. The points seen in Figure 1, the scattergram for HHIE-S as a function of AI-BE, were fit with a least square curve (3rd order polynomial). It shows that scores on the HHIE-S remain similar, with self-perceived hearing handicap being low, until an AI of approximatly 75% is reached. The regression line shows a decrease in the amount of perceived hearing handicap for AI's in the 10-40% range. This was apparently caused by the fact that few data points were available in this range and the tendancy for the self-reported hearing handicap to be variable for a given degree of hearing loss. We also see the points on the scatterplot that represent persons with a high AI (high audibility of speech at a conversational level), and a high score of self-perceived hearing handicap. This trend would suggest an exaggeration of reported handicap although some points represent people with asymetrical hearing loss.

The HHIE-S scores have been averaged and plotted as a function of AI in Figure 2. The average HHIE-S scores were 13.5 when the AI-BE was between 91 and 100%, 5.5 when the AI was between 81 and 90%, and 10.33 when the AI was between 71 and 80%. As the AI decreases further, the self-perceived hearing handicap increases. The average HHIE-S scores for AI's between 61 and70%, 51 and 60%, and less than 50% were 23.8, 24.67, and 27.25, respectively. Scores near the maximum HHIE-S (severe handicap) were observed in the range below 65%. Figure 3 shows average HHIE-S scores plotted as a function of AI-PE. Average HHIE-S scores were 10 when the AI-PE was between 91 and 100%, 6 when the AI was between 81 and 90%, 16 when the AI was between 71 and 80% and 12.5 when the AI was between 61 and 70%. As the AI decreases further, the self-percieved hearing handicap increases. The average HHIE-S scores for AI's of the poorer ear between 51 to 60%, and less than 50 were 16.8, and

27.2, respectively. There was no definate relationship for HHIE-S and AI for the poorer ear until the AI dropped below 65%.

The results of the present study indicate PE and BE results correlate approximatly equally well with HHIE-S. This finding may be attributed to the fact that most of the subjects within this study had symmetrical hearing losses. Only 8 of 40 had differences in PTA's of 15 dB (HL) or more. Among those subjects with asymmetrical hearing losses the poorer ear contributed to the perceived hearing handicap. The average HHIE-S score for unilaterally impaired listeners was 13.6 indicate mild to moderate hearing handicap, and the average HHIE-S for subjects with normal binaural hearing sensitivity was 7.6 indicating no perceived hearing handicap according to Ventry and Weinstein (1983).

The results of this study also indicate that pure-tone average and articulation index scores correlate equally well with HHIE-S scores. Within the computation of AI high weightings are given to those frequencies that make up the pure-tone average (500, 1000 and 2000 Hz). This results in a high correlation (r=-0.89) between articulation index scores and pure-tone averages of the subjects within our study.

CONCLUSIONS

An important point pertaining to hearing screenings for an elderly population emerges from this study. Some degree of self- perceived hearing handicap is expected when the AIfor the better ear is less than 75% or the AI for the poorer ear is less than 65%. When AI's are higher it is difficult to distinguish among subjects based on their percieved hearing handicap. Typical audiometric configurations that would yield AI scores near 75% are seen in Figures 4 and 5. According to Ventry and Weinstein's

(1986) screening protocol, these types of hearing loss constitute a failure of their screening procedure because of the inability to hear a 1000 or 2000 Hz tone at a level less than 40 dB (HL), in either ear.

Because there is considerable variability in the relationship between hearing handicap and AI for individuals, if screening criteria are to be based on the relationship of hearing handicap and AI, averaged data should be used. Then a statement can be made about the expected hearing handicap once the AI has been calculated. For an individual case, however, the expected self-reported hearing handicap and the hearing handicap actually reported may not be in agreement for a variety of reasons.

Based on the results of this study, the following classifications would be recommended. (1) AI greater than 75% for the better ear and greater than 65% for the poorer ear: This would constitute a pass on the hearing screening test. No significant self-reported hearing handicap would be anticipated. (2) AI between 65 and 74% for the better ear: This would constitute a fail on the hearing screening test. At least a mild self-reported hearing handicap would be anticipated. (3) AI less than 61% for the better ear: This would consitute a fail on the hearing screening test. A severe self-reported hearing handicap would be anticipated. (4) AI less than 65% for the poorer ear: This would constitute a fail on the hearing screening test. At least a mild self-reported hearing handicap would be expected. Figures 4, 5, and 6 are examples of failures using the AI-BE criteria. The figures represent, a sloping hearing loss above 1000 Hz with a threshold at 2000 Hz of at least 50 dB (HL), a flat moderate hearing loss at 40 dB (HL), and a sloping hearing loss above 2000 Hz with a threshold at 4000 Hz of at least 90 dB (HL).

TABLE 1.0 The average values for the forty subjects.

	HHIE-S	PTA-BE	PTA-PE	AI-BE	AI-PE
MEAN	18.4	28.4dBHL	36.8dBHL	69.9%	56.2%

TABLE 2.0 Correlations between HHIE-S and audiometric data.

PTA-BE	AI-BE	AI-PE	PTA-PE	HFA-BE	HFA-PE	LFA-PE	LFA-BE
.544	-.518	-.54	.548	.445	.479	.323	.318

TABLE 3.0 Correlations of HHIE-S and AI using linear and nonlinear models

	LINEAR		NONLINEAR	
	AI-BE	AI-PE	AI-BE	AI-PE
R	.518	.54	.637	.555
R-squared	.269	.292	.406	.308

REGRESSION FOR HHIE-S AND AI-BE (CUBE)

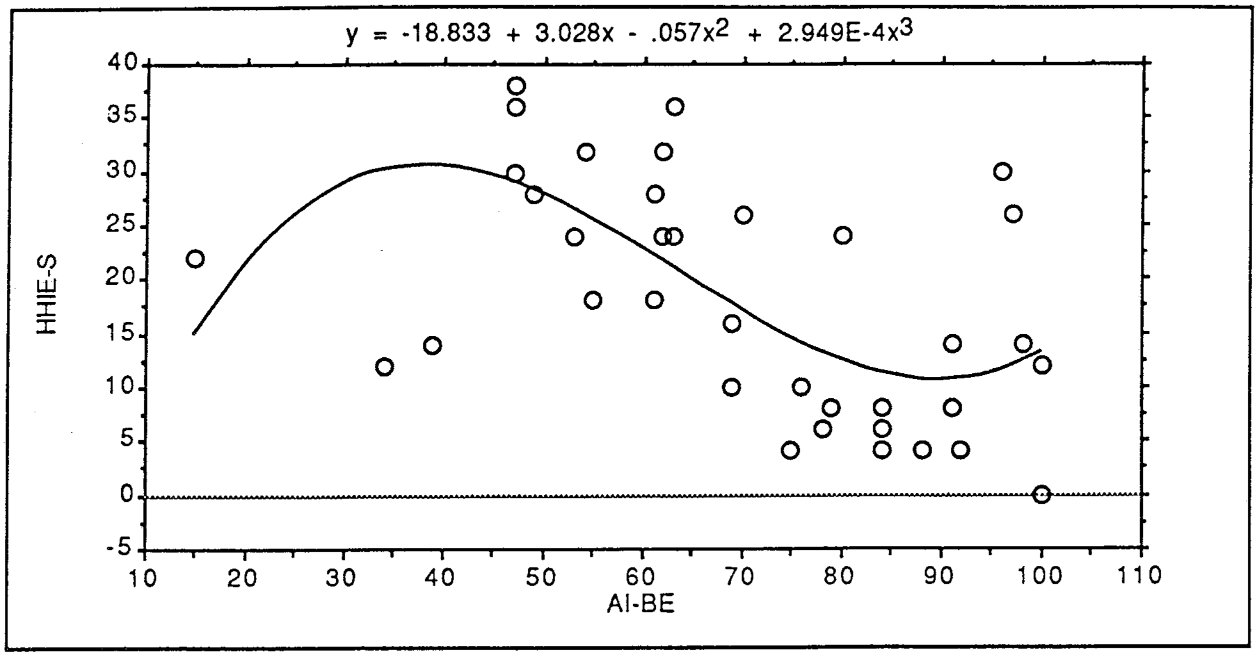

FIGURE 1

Expected Scores on the HHIE-S as a Function of AI-BE

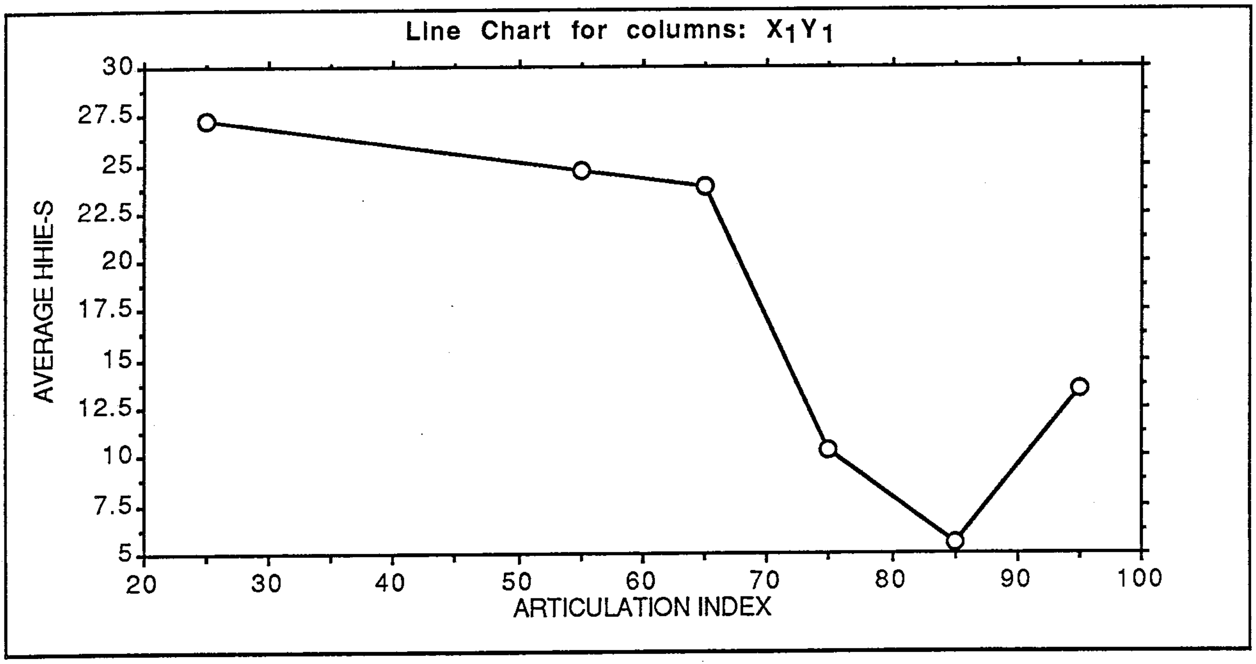

Figure 2

Expected Scores on the HHIE-S as a Function of AI-PE

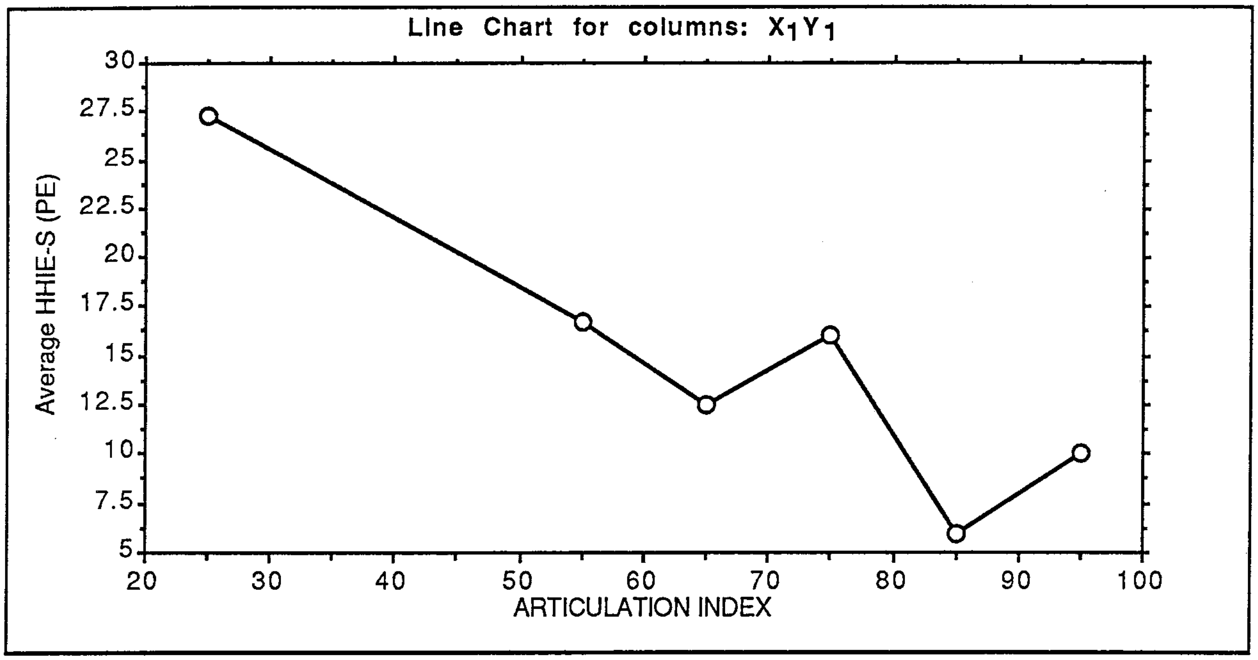

Figure 3

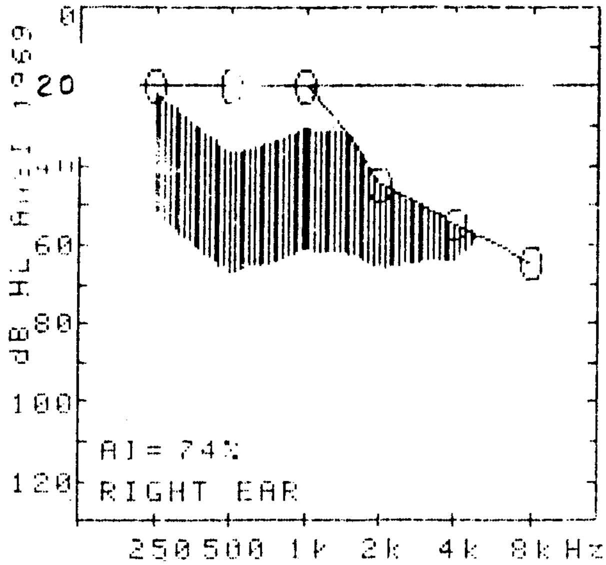

Figure 4

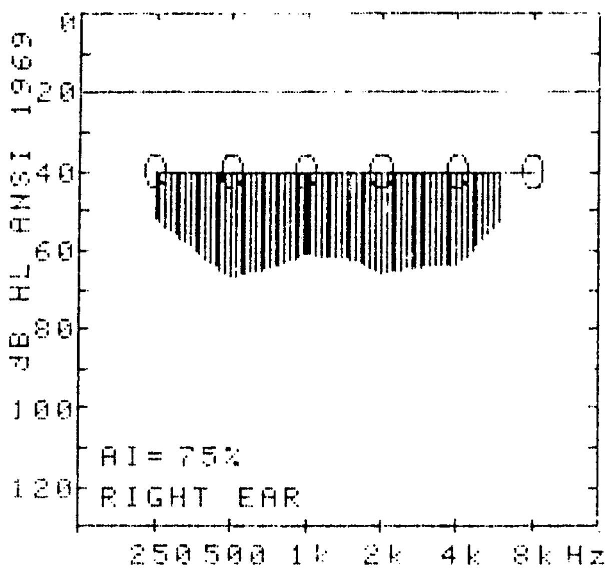

Figure 5

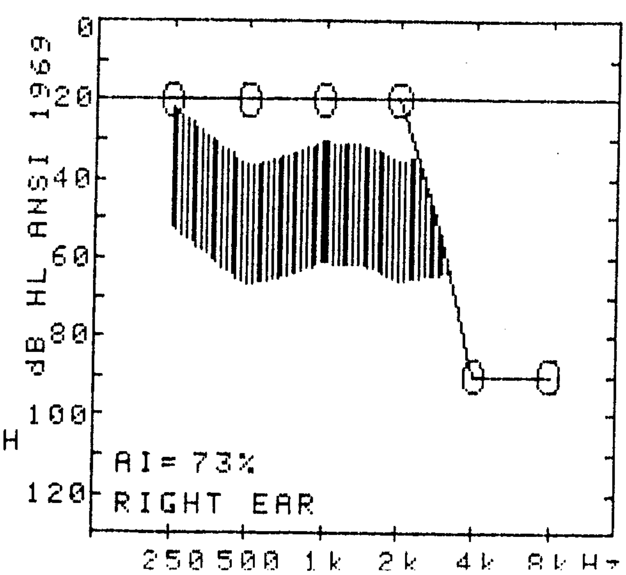

Figure 6

HHIE-S

Name______________________ Date______________________

	YES	SOME-TIMES	NO
E-1. Does a hearing problem cause you to feel embarrassed when meeting new people?	___	___	___
E-2. Does a hearing problem cause you to feel frustrated when talking to members of your family?	___	___	___
S-1. Do you have difficulty hearing when someone speaks in a whisper?	___	___	___
E-3. Do you feel handicapped by a hearing problem?	___	___	___
S-2 Does a hearing problem cause you difficulty when visiting friends, relatives, or neighbors?	___	___	___
S-3. Does a hearing problem cause you to attend religious services less often than you would like?	___	___	___
E-4. Does a hearing problem cause you to have arguments with family members?	___	___	___
S-4. Does a hearing problem cause you difficulty when listening to TV or radio?	___	___	___
E-5. Do you feel that any difficulty with your hearing limits or hampers your personal or social life?	___	___	___
S-5. Does a hearing problem cause you difficulty when in a restaurant with relatives or friends?	___	___	___

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