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A study of hearing aid user satisfaction based on the hearing aid performance inventory

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A STUDY OF HEARING AID USER SATISFACTION BASED ON THE HEARING AID PERFORMANCE INVENTORY

Independent Study

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ABSTRACT

The Hearing Aid Performance Inventory was used to serve 3 main purposes: 1) to validate the hearing aid fitting procedures used at Central Institute for the Deaf; 2) to determine whether the HAPI is a valuable method of follow-up for hearing aid patients; 3) to ascertain from the responses, which situations pose the greatest difficulty, and what characteristics of the patient or his hearing loss might contribute to those difficulties.

The responses suggested that the fitting procedures of Central Institute for the Deaf (CID) are valid. Examination of the HAPI responses revealed correlation of HAPI scores to: A) severity of hearing loss with the most severely impaired rating the lowest (best); and B) Prior Experience, with new users rating the best.

Overall the HAPI was found to be a useful tool to assess patient satisfaction with hearing performance and to facilitate communication between the hearing aid patient and clinician.

I. INTRODUCTION

When selecting and fitting a hearing aid properly, the audiologist must consider several factors, such as optimum frequency response, adequate intensity, normal loudness response, maximum output limitations, and improvement of speech discrimination abilities (Schmitz, 1980), in order to optimize the patient's success with the aid. The ultimate goal of hearing aid selection procedures is to allow the patient successful use of amplification in everyday situations. Therefore, one way to validate the selection of the aid is based on the helpfulness of the hearing aid in everyday communication. Since there are no direct clinical tests that can be used to measure the "helpfulness" of an aid to an individual in everyday communication, judgments of the hearing aid user may be obtained to acquire such information.

The patient's judgment of the performance of his hearing aid conveys the helpfulness of the aid, not in the clinic, but out in the real world in a variety of listening conditions. Although considerable research has been conducted in the area of hearing aid fitting, relatively few investigators have measured performance of hearing aids outside the clinical environment. This performance is difficult to measure because it is not feasible to set up situations in the lab that are analogous to the patient's daily listening situations. However, Walden (1982) has suggested some possible validation measures of hearing aid success. These measures include (1) frequency of use, (2) frequency of changes in fitting, (3) acceptability ratings by the patient, and (4) some

statement of specific benefit provided, as obtained from the patient via telephone interviews, post-fitting clinical visits, or questionnnaires. In a subsequent study, Walden (1982) found the questionnaire method for measuring the specific benefit provided to be useful in validating hearing aid selection procedures for patients seen at the Walter Reed Army Medical Center.

Although the use of patient inventories is not widespread among clinicians, the idea is not a new one. In 1960, Green and Folk at the University of Utrecht developed a questionnaire which has been modified for use in other countries in the Netherlands. Kapteyn (1977) wrote about one version used at the Free University Hospital in New Amsterdam, which included questions such as: "Do you use the hearing aid in large, lively company?" "Can you distinguish where a sound comes from with your aid?" "How does the sound of your aid appeal to you?"

A number of other self-report procedures (Nett, Doerfler & Matthews, 1960; Dirks and Carhart, 1962; High, Fairbanks, and Georig, 1964; Shein, Gentile, and Haase, 1965; Northern, Ciliax, Roth, and Johnson, 1969; Noble and Atherly, 1970; Lamb, 1971; Ewertson and Birk-Nelson, 1973; Sandars, 1975; Alpinen, 1975) have been used to gain more descriptive information from patients beyond that obtained from clinical testing. Giolas, Lamb, Owens and Schubert (1979) stated that the above questionnaire procedures failed to provide comprehensive assessment of the hearing aid wearer's response in a variety of listening situations. Thus, Giolas, et al. devised a Hearing Performance Inventory (H.P.I.) as

a more systematic procedure for identifying a variety of problem areas experienced by persons as a result of their hearing impairment. However, with 158 questions, the HPI was quite time-consuming to administer. Walden (1982) used a 64-item questionnaire and, after much analysis, concluded that the questionnaire is a valid criterion measure for validation of hearing aid selection procedures. Walden demonstrated that his inventory has a high internal consistency reliability. The reliability [Using the Spearman-Brown formula (Nunally, 1978)] of a 32-item version of the questionnaire is .92 and for a 16-item version is .86.

Self-assessment scales for measuring hearing handicap have been recognized as a useful adjunct to the basic clinical audiometric measures to describe the communicative difficulty experienced by the hearing-impaired individual. For example, (Hawes and Niswander 1985) compared responses on self assessment tools for hearing handicap with audiometric measures of hearing loss. they found that patients expressed more difficulty than would be predicted based on the audiogram alone. This study pointed out the inability of the traditional hearing evaluation to accurately reflect the patient's perceptions of his difficulties. Likewise, it is probable that measures of hearing sensitivity and discrimination with a hearing aid fail to effectively show the extent of the patient's difficulties in listening with amplification. Therefore, a self-report measure for performance of hearing aid should be useful in quantifying hearing aid performance.

Self-report measures of hearing handicap, including the Denver Scale of Communication Function and the Social Hearing Handicap Index, (Apiner, 1978), have enjoyed more popularity in recent years than any self-report measures of hearing aid satisfaction. The hearing handicap inventories are similar to the hearing aid performance inventory in function and purpose; both are used to assess the patient's functioning in a number of situations, and both concern rehabilitation of the patient. For these reasons it seems feasible that the HAPI can be used as effectively and should be accepted by clinicians as readily as the self-report measures for hearing handicap.

The present study was designed to meet two objectives through the administration of the HAPI. First to ascertain the validity of the hearing aid fitting procedures used at the Central Institute for the Deaf (C.I.D.) clinic (Pascoe's procedure). If the hearing aid procedure is valid, the patients should be hearing with the optimal amount of assistance and should score low (well) on the HAPI. The vital question is not whether the patient is satisfied listening in a sound treated room, but whether the patient is satisfied with the help he receives from his hearing aid in everyday life.

The second objective is to obtain follow-up information on individual patients. It is important to know whether the patient is coping well with the hearing aid and what specific problems he may be having with the aid. To the extent that this information identifies specific problems, review by the clinician could lead to modifications in the fitting.

There may be certain characteristics of the individual patient or of his particular hearing loss which make him perceive less benefit than others who do not have those characteristics. If so, how can these factors be compensated for? Can adjustments be made to alter the aid, the listening environment, or perhaps the patient himself. That is, can listening skills or motivation and attitude be improved in the individual? It would be desirable to improve the above factors to the extent of improving the perceived benefit derived from the hearing aid.

In this study, both situational features and patient characteristics which appear to be correlated with problems experienced by hearing aid users will be identified and, if possible, suggestions for remediation of these problems will be made.

II. METHOD

The Questionnaire

The HAPI consists of 30 items which describe various listening situations that may be encountered by the average person in everyday life (e.g., "You are talking to a friend outside on a windy day.") The subject is asked to imagine himself in each situation and rate the benefit derived from his hearing aid. A response sheet is provided on which the subject is to rate the hearing aid for each situation listed. The rating scale has 5 points as follows: 1) very helpful, 2) helpful, 3) very little help, 4) no help, and 5) hinders performance. A "does not apply" response is also provided. A patient information sheet, which was printed on the reverse side of the response sheet, provided

information on age, occupation, which ear was aided, etc. This form also provided space for the patients to list those situations in which their hearing aids are found to be most beneficial and those in which they are least beneficial. Lastly, a space was provided for the patient to offer any additional comments. The HAPI questionnaire and response sheet can be seen in Appendix A.

Survey Procedure

At the onset of this study, Hearing Aid Performance Inventory forms were sent out to all hearing aid patients who had been fitted at C.I.D. As a result of this initial mailing, the forms were received by patients who had been fitted 1 to 9 months prior to receipt of the form. The time period that the patients had their hearing aids was measured from the date of trial of the aid to the date the questionnaire was mailed. In all later mailings, forms were sent approximately 6 months after the date of trial. The focus of this study will be the sample of "six-month hearing aid users." A six-month time period was chosen because it was believed to be ample time to allow the hearing aid user to adjust to his new aid and to acquire considerable experience with a number of different listening situations.

Subjects

Subjects in this study consisted of 50 patients who have purchased hearing aids from the C.I.D. clinic. Twenty-eight males and twenty-two females from 20 to 89 years of age (mean age 66 years) participated.

Degree of hearing loss of patients in the sample was most often described by clinicians in audiological reports, as moderate or severe. The sample included 42 subjects with sensorineural loss, 7 cases of mixed hearing loss, and 1 case of a conductive loss.

Onset of hearing loss varied among patients although most reported a gradual progression of hearing loss occurring over five years or more prior to being fitted with an aid. Thirty-five subjects were first-time hearing aid users, while 15 had previously worn hearing aids. Of the 15 who had previously worn a hearing aid, experience with an amplification device ranged from less than 1 year to 22 years. With respect to daily use of the hearing aid, the least amount of use was reported to be one hour per day and the greatest amount of use was 18 hours per day; 77% wore their aids more than 8 hours per day.

A wide variety of hearing aid makes and models were represented in the sample of subjects, [e.g., Starkey (n=10), Widex (n=9), Telex (n=6), and Qualitone (n=6)]. Thirty-nine patients were fitted monaurally, while only 11 were fitted binaurally. Most of the subjects were fitted with ear level aids.

Scoring

The HAPI questions were scored for each item by assigning values ranging from "1" for "very helpful" to "5" for "hinders performance." Since each item represents a certain listening situation, the situations in which the patient's hearing aid is helpful can be identified, as well as those situations in which the aid is not helpful.

Certain situational features within each item were examined by Walden (1982) to find which, if any, are related to the benefit reported by the patient. Twelve bipolar features used in this study represent parameters of the listening situation or of the signal which may affect the benefit perceived from amplification. A list of these situational features are included in Appendix B.

An overall rating score for each patient, derived by averaging scores for all the items, was taken to represent the patient's overall rating of the helpfulness of his hearing aid in daily life. H.A.P.I. scores were averaged across patients for each question in an attempt to find which factors influence some patients to rate their hearing aids more highly than others. Ratings were examined in conjunction with patient information: 1) type of hearing loss; 2) degree of hearing loss; 3) prior experience with amplification; 4) extent of hearing aid use per day; 5) monaural vs. binaural amplification; 6) improvement of articulation index with hearing aid.

III. RESULTS AND DISCUSSION

1. Type of Loss

Hypothesis: Patients with conductive hearing loss derive greater benefit from hearing aids than those with sensorineural loss. In a conductive loss, the cochlea is not damaged and the amplified signal can be processed normally. A sensorineural loss, however, affects the functioning of the cochlea so that even with sufficient level of sound energy, the cochlea can't process the signal normally.

Results. A valid test of the original hypothesis for results depending on "type of loss" could not be accomplished because only one subject in the study had a purely conductive loss. Therefore, the 42 subjects with sensorineural hearing loss were compared to the 8 subjects with conductive or mixed loss. The overall score for the conductive/mixed loss group was 2.15 (standard deviation = .55). The overall score for the sensorineural group was 2.15 (standard deviation = .49). No significant difference was observed between the scores of the two groups. ($t = .44$, $p = .33$.) A graphic representation of the two groups' scores can be seen in Figure 1.

Discussion: The results of this analysis suggest no significant difference in perceived hearing aid user satisfaction between patients with sensorineural loss and those with predominately mixed loss. Mixed loss, of course, has a sensorineural component as well as a conductive component. It is possible that those patients with mixed loss may have received help with the conductive component (i.e., the sound amplified enough to be transmitted to the cochlea), but since a sensorineural component exists, as well, they may experience the same difficulties as patients with a pure sensorineural loss (i.e., difficulty understanding speech, listening in a noisy background, etc.). For this reason, many of the situations described in the questionnaire may pose similar difficulties for both groups. If responses from a sample of patients with purely conductive hearing loss could be

obtained, it would be interesting to see if their scores were significantly better than both the mixed and sensorineural groups, which would support the original hypothesis.

2. Degree of Hearing Loss

Hypothesis: Patients with a moderate hearing loss will perceive more benefit than those with a mild or severe loss. Those with a mild loss already hear fairly well, and the aid may not provide a dramatic improvement. Those with a severe loss have considerable distortion of the signal by the cochlea, which cannot be overcome by a hearing aid.

Results. Patients were categorized into 3 groups (i.e., mild, moderate, and severe to profound based on speech reception threshold (SRT). The mild category (SRT 0-40) consisted of 31 patients with a mean score of 2.23, (standard deviation = .43). The moderate category (SRT =41-55 dBHL) consisted of 9 patients with a mean score of 2.39 (standard deviation = .69). The severe-profound group SRT = 56-90 dBHL) consisted of 8 patients with a mean score of 1.69, (standard deviation = .28).

A one-way analysis of variance showed a significant difference among the scores of the 3 groups ($F = 5.4$, $P = .008$), (Fig. 2a). Individual t-tests were then performed on pairings among the 3 groups to find which groups were significantly different in score from the others. The results showed a significant difference between scores of the mild severe-profound group (Figure 2c), as well as between scores of

the moderate and severe-profound group (Figure 2d). No significant difference was observed between the mild and moderate group (Figure 2b).

Discussion: It is interesting to note that most patients in the study fit into the mild category based on SRT. It should be noted that the majority of patients fitted with hearing aids had greater hearing loss in the high frequencies, thus the SRT's may underestimate the degree of actual hearing loss. It is, nevertheless, a measure which can be used with some consistency across patients to estimate the amount of usable hearing for speech sounds.

Based on the statistics stated above, patients with severe-profound hearing loss tended to rate the performance of their aids higher than those with mild or moderate degrees of hearing loss. There are at least two possible reasons for this outcome. First, perhaps the patient with a severe-profound loss perceives more benefit from a hearing aid because he has more to "gain" from a hearing aid. He has a greater need for amplification, and experiences a greater difference in listening to sounds with and without the hearing aid. Even though patients with a more severe loss may actually have a more difficult listening task than those with milder loss, they may notice such an improvement in their aids over the unaided condition, that they tend to perceive better performance of their aids than people with milder losses. For patients with a

severe to profound hearing loss, the hearing aid often means the difference in hearing something versus hearing nothing.

Another explanation of the different ratings among groups might be in patient expectations. The majority of the patients with mild losses claimed to have a gradual onset of hearing loss within the past few years. In contrast, patients with more severe degrees of hearing loss tended to have more definitive onset, occurring a greater number of years ago. Many of these patients had congenital hearing loss or a loss occurring in childhood.

Possibly the group with gradually progressive and recently obtained hearing loss may expect too much from a hearing aid. They may compare their hearing with an aid to the normal hearing they had a few years ago, and they may expect the aid to restore their hearing to normal. This expectation, of course, cannot be fulfilled by the hearing aid.

The patients with more severe losses and usually with a longer history of hearing impairment may be more accustomed to the unclear signal. Since they have been forced to deal with a greater degree of impairment on a daily basis, perhaps they can deal with the amplified signal with more tolerance than patients with better hearing.

3. Experience With Amplification

Hypothesis: Patients experienced with hearing aid use will rate the helpfulness of their aids more highly than patients without prior experience.

Results: Patients' scores were divided into 2 groups. 1) Patients who have had prior experience with hearing aids (n=15) and 2) first-time hearing aid users (n=35). The 15 patients with prior experience varied in the length of time they had used amplification, ranging from 1 year to 22 years (mean number of years = 8). The mean HAPI score of experienced hearing aid users was 2.46 (standard deviation = .60). The mean score for the group of first-time hearing aid users was 2.07 (standard deviation = .40). A t-test for the two groups indicated that there is a significant difference between the scores of the 2 groups ($t = 2.89$, $p = .003$), with the first-time hearing aid users rating the performance of their aids more highly than the group who had worn aids prior to this study. (See Figure 3a.) These results do not appear to be due to the effects of severity of hearing loss. As shown below similar percentages of patients have moderate, severe, and profound hearing losses for both new and old users.

Severity of HI	New Users (n=35)	Old Users (n=15)
Moderate	21	8
Severe	13	6
Profound	1	1

Discussion. These findings are opposite to the stated hypothesis. In retrospect, it may be speculated that the experienced hearing aid users may be more harsh judging performance. The experienced hearing aid user often has gotten used to the characteristics of his old aid, and when a new device is used, he may have problems accepting it. He may think the aid does not sound right if it does not sound the same as his old aid. The new user, on the other hand, may rate his aid more favorably since his hearing is suddenly improved by the hearing aid. The new user probably makes judgments of listening with his hearing aid in comparison to how he heard before with no amplification, while the experienced hearing aid user may be making comparisons to his old aid. Since the former probably notes a bigger improvement between the 2 conditions (aided vs. unaided), that difference is probably reflected in his HAPI scores.

Since it was decided rather arbitrarily to send the questionnaires to patients after a 6-month period of use, we were interested to know whether trial periods shorter or longer than the 6-month interval might affect the way patients respond to items in the HAPI. Therefore, a comparison was made of patients' ratings based on extent of experience with the aid before answering the questionnaire.

Patients who had hearing aids for more than 1 year were excluded. Scores of patients who answered the questionnaire 1 month to 1 year after they had received the aid were compared. Scores ranged from 1.30 to 3.57. The mean score was 2.21 (standard deviation = .49). The mean number of months with the aid was approximately 6 months (standard deviation = 4.5 months). Correlation between the number of months with the aid and HAPI scores was insignificant. (See Figure 3b.)

4. Hearing Aid Use - Hours of Wearing Time Per Day

Hypothesis. Patients who wear their aids extensively throughout the day will indicate greater satisfaction on the HAPI than patients who wear their aids only a few hours per day.

Results. Scores of the respondents were divided into 2 groups as follows: (1) extensive use - patients who reported 12 or more hours/day of wearing time (n=30); (2) limited use - patients who reported 8 or less hours/day of wearing time (n=9). (There were no patients reporting 9-11 hours/day). Mean scores for the 2 groups were 2.14 (std. deviation = .53) for the extensive use group and 2.32 (std. deviation = .43) for the limited use group. Scores for the two groups were not significantly different (t=.95, df=37, p=.17). The distribution of hearing aid use (hours/day) among subjects can be seen in Figure 4. The range was from 1 to 18 hours/day with

a mean of 12.2 hours/day. As seen in Figure 4, the majority of the patients surveyed used their aids between 12 to 16 hours/day.

Discussion. Although results were in the expected direction, i.e., extensive use patients expressed greater satisfaction than limited use patients, the difference in scores failed to reach significance at the .05 level. In general, the respondents use their aids extensively with only 9 out of 38 respondents wearing their aids less than 12 hours per day.

The two patients with the shortest wearing time (1-2 hours/day) gave very disparate reasons for their restricted usage. One patient with a moderate sensorineural hearing loss commented that she did not need the aid in most situations, but she wore it when lecturing to a college class so she could hear students' questions. The other subject with extremely restricted use was an 81-year-old retired woman with a moderate sensorineural hearing loss (sloping configuration). She wore her aid when watching TV, and reported that in other situations the sounds were not loud enough without the aid. The patient with the most extensive usage (18 hours/day) was a 58-year-old who works as an office clerk. She also has a moderate sensorineural hearing loss (flat configuration). She reported noticeable improvement at work with the aid and "vast general improvement" in all situations.

5. Monaural Vs. Binaural Fitting

Hypothesis. Patients fitted with binaural amplification will perceive more benefit than those fitted with only one hearing aid.

Results. Patients' scores were grouped into 2 categories according to whether the hearing aid fitting was monaural or binaural. Surprisingly, only 11 fittings of the 50 fittings were binaural. The mean score of the binaural group was 2.07 (standard deviation = .39) which was lower than the mean score of the monaural group which was 2.19 (standard deviation = .54). However, the difference observed was not significant ($t=.6878$, $P=.247$). See Figure 5.

Discussion: Assuming that patient ratings are a true representation of benefit provided by the aid, the outcome may dishearten those who believe in or advocate the importance of binaural amplification. Much of the literature on amplification stresses the importance of binaural amplification, and most clinicians seem to support the idea of a binaural fitting to improve listening in everyday situations. Among the advantages of hearing binaurally is the ability to localize the source of a sound by comparing the cues of intensity or phase between the two ears. Binaural hearing also allows one to hear sounds on both sides of the head. A handicap imposed by using only one aid is that often the aid is on the opposite side of the head from the sound source, and is shadowed from the primary message. Binaural amplification also

serves to improve the speech-to-noise ratio by about 3 dB (Silverman and Pascoe, 1978) and recreates an auditory sense of space.

With all the advantages of binaural hearing and fittings, why did the binaurally fitted patients in our study fail to indicate a greater degree of satisfaction with their aids than the patients with monaural amplification. The discrepancy could be attributed to inappropriately using "binaural amplification" and "binaural hearing" as synonomous terms. Binaural amplification is the use of hearing aids on both ears, but binaural hearing as it is discussed in the literature, most often refers to the two ears receiving an equivalent input, thus enhancing abilities for localization, improved speech to noise ratio, etc. While attempts are made to adjust the response of an aid to make the 2 ears symmetrical, the task is often impossible.

6. Percent of Improvement of Articulation Index

Hypothesis: Patients with greater percentage of improvement of AI as the result of amplification will perceive more benefit from their aids than patients with less change in AI. The Articulation Index represents the amount of the speech energy that is audible. Higher values of AI indicate the chance of better speech intelligibility and therefore increased benefit from the aid. When the difference in unaided vs. aided AI is greater, the patient will be expected to perceive more benefit from his aid.

Results. HAPI scores were compared as a function of the percentage of improvement of the AI from the unaided to the aided condition. (See Figure 6.) The mean percent of AI improvement was 37.6 (standard deviation = 18.8). No significant correlation was observed between percentages of AI improvement and the patients' scores.

Discussion. The AI is an indication of the amount of speech energy which is audible for the patient. It is usually assumed that by making more of the speech signal available to the listener, he or she will have a greater opportunity to use the speech in a beneficial manner. Based on this assumption, it was predicted that the greater the improvement from unaided to aided AI, the more benefit the user would perceive. However, there was not a significant correlation between percent of improvement in AI and HAPI scores. There are several reasons why no significant correlation was obtained. Possibly the HAPI questionnaire is not sensitive enough to discriminate among the patients of this sample based on AI improvement. It is impossible to isolate the effects of AI and to examine the patients' judgments which are based on changes in AI. Certainly patient satisfaction is linked to other factors, as well (e.g., appropriate loudness, quality of sound, etc.).

Informal assessment was made of the patients' scores in relation to the value of the absolute aided AI. Scores of patients with the highest aided AI's were similar to those of patients having the least aided AI's, (i.e., mean score = 2.10 and 2.17, respectively).

PATIENTS' COMMENTS

In addition to the information acquired from the responses to questionnaire items, patients were asked to describe when their hearing aids are most beneficial and least beneficial (see Appendix I for a summarized listing of these situations.

According to client comments, aids offer the least benefit in "situations with background noise." The second most often occurring complaint was "crowds," or "situations with more than one speaker." Both of these situations present the individual with a difficult listening task; that is, the signal he is listening to is masked or interrupted by a competing noise signal. Often, these two signals are described by the patient with sensorineural hearing loss as being "jumbled." In other words he is unable to separate the desired signal from the background noise. Unfortunately, the hearing aid is not capable of alleviating this problem since the aid does not selectively amplify one sound source over another (unless they are very different in frequency, and the frequency response of the aid happens to be set so that one sound is not amplified as

to the patient's difficulty is the seating arrangement. Usually passengers in a car are side-by-side, facing forward, or one is behind the other. In either case it is very difficult to have a face-to-face conversation (especially if one is the driver). Although a patient's aid may help somewhat in the car, he may miss some visual cues which he would normally integrate with the sound he receives via his hearing aid. In addition, the amplified car noises mentioned earlier may mask the auditory signal, as well.

Now the question must be considered, "What can be done to make a hearing aid more beneficial in these 'noisy situations?'" In some instances where the aid cannot overcome the obstacles of the situation (perhaps in a car, for some patients) the best action to take might simply be to turn the aid down or off to avoid the annoyance of the noise. Alternatively, a direct audio input system may benefit the user by increasing the signal to noise ratio. Hearing aid users should be counseled with respect to other assistive devices which may improve their ability to listen in adverse circumstances.

In other situations, however, it might be feasible to make adjustments to the aid which will lessen the amount of amplified noise. For example, an adjustable tone control may be used once again so the patient can change it according to the situation (i.e., a low frequency cut to diminish low

frequency noise). In the case of wind noise, the clinician may consider recommending a wind screen for the hearing aid.

Talking on the telephone was reported by several to be helped little by a hearing aid. It might be wise for the clinician to follow up on these patients to see if they have a telephone coil in their aids and to make certain that the coil is working properly. Telecoils are often unreliable and may require volume adjustment by the patient. The patient may need instruction to use the switch to activate and adjust the device. In cases where the patient's hearing is too severely impaired to use a telephone, he may be taught to use a TTY (teletype). When a TTY is not a practical answer for this problem, because the people whom he calls do not have those devices, the patient may be informed of any services available to assist him in making phone calls. For example, in St. Louis there is a telephone service for the deaf called CONTACT St. Louis in which workers relay phone messages from deaf callers via TTY to hearing people via telephone and vice versa. Individuals who are not able to communicate by telephone can also be taught a code system for use with family and friends (Erber, 1982).

Situations in which the "speaker's back is turned," the "speaker is at a distance" or the "speaker has a soft voice" were also noted to be helped little by a hearing aid. Hearing aid users may need counseling in dealing with these problems. He must realize that sometimes he must simply tell the person

who is speaking to him to face him, to come closer, or to speak up. At times it is necessary for the hearing aid patient to manipulate his environment in order to get a usable auditory signal and the environment may include the speaker. People can usually easily accommodate the hearing impaired listener, when informed, and most are willing to doso. An extra 10 dB of voice can be produced with little effort on the speaker's part (Niemoeller, 1978).

At "movies or the theater," "in church," and "at lectures" were situations in which some felt their hearing aids were least beneficial. One way the patient may improve his chances of understanding speech in these situations is simply by preferential seating. He may hear more of the signal if he sits near the front or near a loudspeaker. It is important that the patient be near the source, especially if the room is not treated well for sound. In a reverberant space (e.g., a large room with hard walls and floors), the ratio of direct to reverberant sounds will decrease as the distance between the sound source and the listener increases. Furthermore, intelligibility decreases as the ratio of direct sound to reverberant sound levels decreases.

Another possibility to consider is using an FM system in these situations. The FM system works similar to a radio station, broadcasting signals which can be picked up with a radio receiver. The wireless microphone conveys the audio signal into radio waves, which are transmitted through the environment and

converted back into an audio signal at the listener's receiver. The FM system used by cooperative speakers in church or lectures may aid the hearing impaired person substantially by providing a significantly greater signal to noise ratio.

The situation listed most often as that in which the hearing aid offers the most benefit was "face-to-face conversations." The second most frequently listed situation with almost as many responses, was "watching TV." Both of these situations presumably would offer a quiet background and an uninterrupted signal at a reasonably close distance. These 2 situations also provide the listeners with visual cues, which may have a big effect on communication when coupled with auditory cues. Another situation listed several times was "a quiet setting." Though we assumed a quiet background in the 2 previous situations discussed, this situation refers to the comments made by patients who specified a quiet setting, e.g., "in a quiet room," "in a place where there is no background noise."

It is interesting to note that some of the situations listed in the "most beneficial" category by the same patients are listed in the "least beneficial" category for others. For example "movies and theater" was claimed to be a situation in which a hearing aid was most helpful for three people but least helpful for two.

Information about hearing aid users' satisfaction was also obtained from open comments given by patients on the response sheet. I feel these comments are a very important addition to

the information elicited by the inventory. The patient comment section allows the patient to communicate difficulties which may not be included in the questionnaire items. For example, two patients reported a problem with moisture in their hearing aids. This is one problem that is certainly not represented in the questionnaire, yet is troublesome to these patients. Once it is brought to the clinicnan's attention, this problem may be easily rectified, e.g., with a Dry-Aid Kit.

PROBLEMS

Some Problems with the HAPI:

The possibility exists that patients may be judging not the benefit of the aid itself, but the difficulty of the described listening situation. Although the instructions emphasize that the difference of the situation should not be judged, it is understandably difficult to separate the two when making judgments of hearing aid performance. This bias can cause misrepresentations of the performance of the hearing aid.

Another problem with the HAPI is that many of the listening situations described may not be appropriate to elicit judgments from the elderly population. For example "You are at a large, noisy party and are engaged in conversation with one other person." "You are with your family at an amusement park and are discussing which attraction to go to next." "You are attending a business meeting with people seated around a conference table." The directions instruct the reader to imagine himself in each

situation, even though he may have never actually experienced such circumstances, and predict how well the hearing aid would perform. Several questionnaires from elderly patients were returned with no response on items to which they could not relate their own listening experiences. Some response sheets had too many items marked "Does Not Apply" to be included in the study. One patient even returned the entire response sheet blank and wrote that he is satisfied with his aid, but the questionnaire does not apply to him since he resides in a nursing home and does not go out much.

Perhaps it would be worthwhile to develop a separate HAPI for more elderly patients. Situations described might be geared toward those in a nursing home or those who live alone with little social interaction. The Denver Scale of Communication Function for Senior Citizens Living in A Retirement Center (DSSC), a type of self-assessment handicap scale, has been developed specifically for use of the elderly. The DSSC was developed by Zarnoch & Alpiner (1977) who recognized the importance of evaluating individuals according to their unique living situation. A similar approach, using questions pertaining to hearing aid performance, may provide a more appropriate inventory for the elderly.

The most critical drawback of the HAPI, or other survey questionnaires that are mailed to patients, is that some questionnaires are never returned. In this study, the return rate was approximately 50%. The questionnaire can be useful only

with the cooperation of the patient. It may be helpful to give the patient a reminder via a phone call or a postcard.

If the patient is suspected to be unable to read and fill out the questionnaire for himself, the clinician may send the HAPI, instead to a nearby friend or relative who might be willing to help the patient to complete and return the questionnaire. The clinician who takes these steps may increase his chances of a "return."

Another possible solution to the lack of returns would be to change the way in which the HAPI is administered: rather than mailing the inventory to patients, the clinician could give questionnaires to patients at a recheck visit. For example, at the end of the 30-day trial period with the aid, the patient could return for a checkup on his hearing aid, and the HAPI could be given to the patient to be filled out in the clinic. Thus 1) the clinician would be assured that the patient did receive the HAPI; 2) chances would be greater that the form would be returned, and 3) the clinician would have ready access to the problems indicated on the HAPI at a time when he can apply the information and adjust the aid or counsel the patient.

IV. CONCLUSIONS ABOUT THE HAPI

The HAPI is a worthwhile procedure to be included in an audiological program. It provides the audiologist with documented validation of the hearing aid fitting. Furthermore, the HAPI is a useful tool for the clinician concerned with

follow-up care for his patients. The clinician can easily identify problem areas which he may then help the patient with. The HAPI may also alert the clinician to possible malfunctioning of the hearing aid which could be corrected.

The most positive aspect of the HAPI is simply that it provides a means of communication between the audiologist and the patient. While clinicians typically do some form of follow-up on a hearing aid patient, it is often within a few weeks from the time he receives the aid, and sometimes no further communication exists between clinician and patient until a re-evaluation one year later. Thus, the HAPI may serve as a device to check up on the patient between the time of fitting and the one-year evaluation.

The questionnaire also seems to be convenient as a form of communication. It allows the patient to read the items, think about them, and answer them at his convenience in his own home. For many, this may be better than making an appointment to come to the clinic, only to give the same information, especially if the patient lives far away or is unable to go out.

The questionnaire method is probably better than a telephone interview to get patient information from hearing-impaired individuals who may have a problem discriminating speech signals over the telephone. However, as noted previously, the correspondence method of using the HAPI is not without fault.

Results of this study showed that patient ratings were concentrated around the same score: 2.18. This could be due to

sample chracteristicsor to failure of the questionnaire to differentiate among patients and their degree of satisfaction. However, by examining the individual item ratings made by each patient, the clinician may get a good idea of how each patient is performing with his aid, and how that performance is affected by different listening conditions. In other words, the overall scores may average out to be similar across patients, but individual differences may occur across patients for a single item. Another explanation of the concentration of scores may be simply that the great majority of patients receiving hearing aid fittings at CID are quite satisfied, finding the overall performance of their hearing aids to be very helpful. Thus, the hearing aid fitting procedures at CID, based on Pascoe's procedure, appear to be validated by the HAPI responses.

The response sheets returned in this study provided valuable information for the audiologist from the comments section. However, a form designed for patients' comments alone probably would not be sufficient for obtaining information. The questionnaire probably helps the patient to think about the performance of his aid and helps him to realize or recall problems he has had with the aid. It may also lead him to realize ways in which the aid helps him. Thus, the patient can use the HAPI to help him to talk about his hearing aid, to weigh pro's and con's of amplification, and help him communicate with the audiologist about his aid.

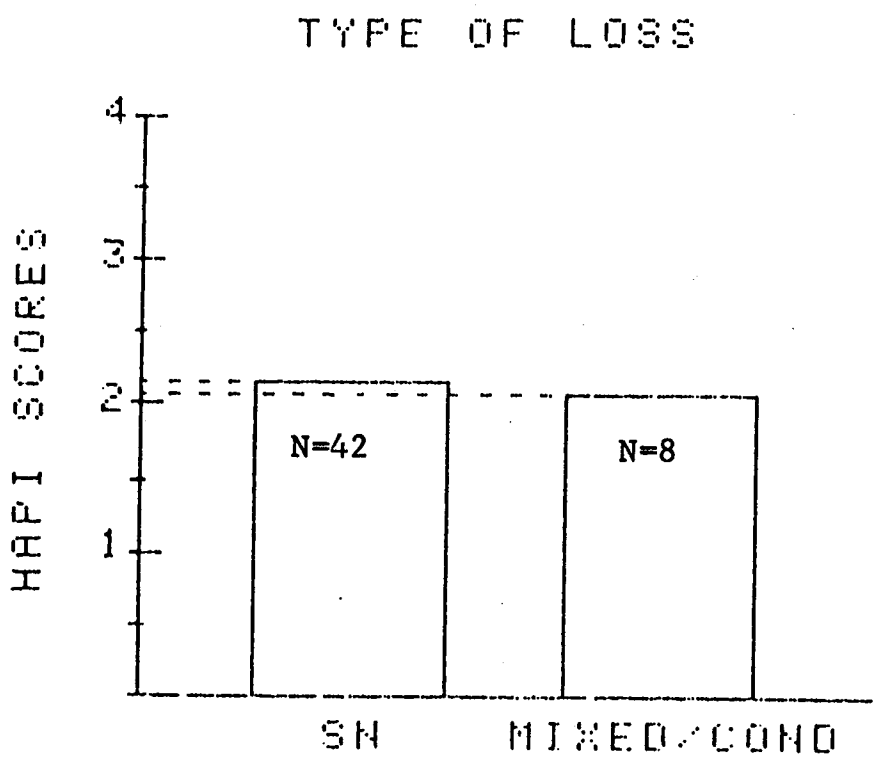

Figure 1. HAPI Scores As A Function of Type of Hearing Loss

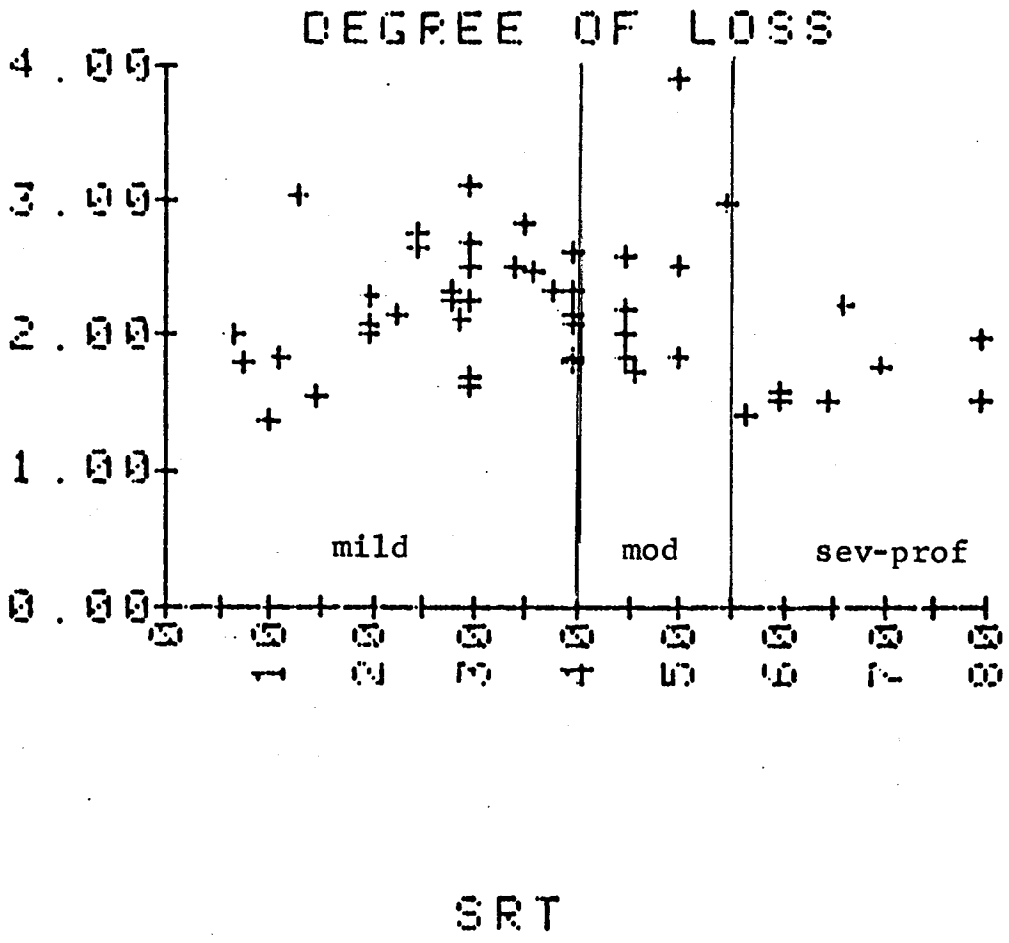

Figure 2a. HAPI Scores As A Function of Degree of Hearing Loss

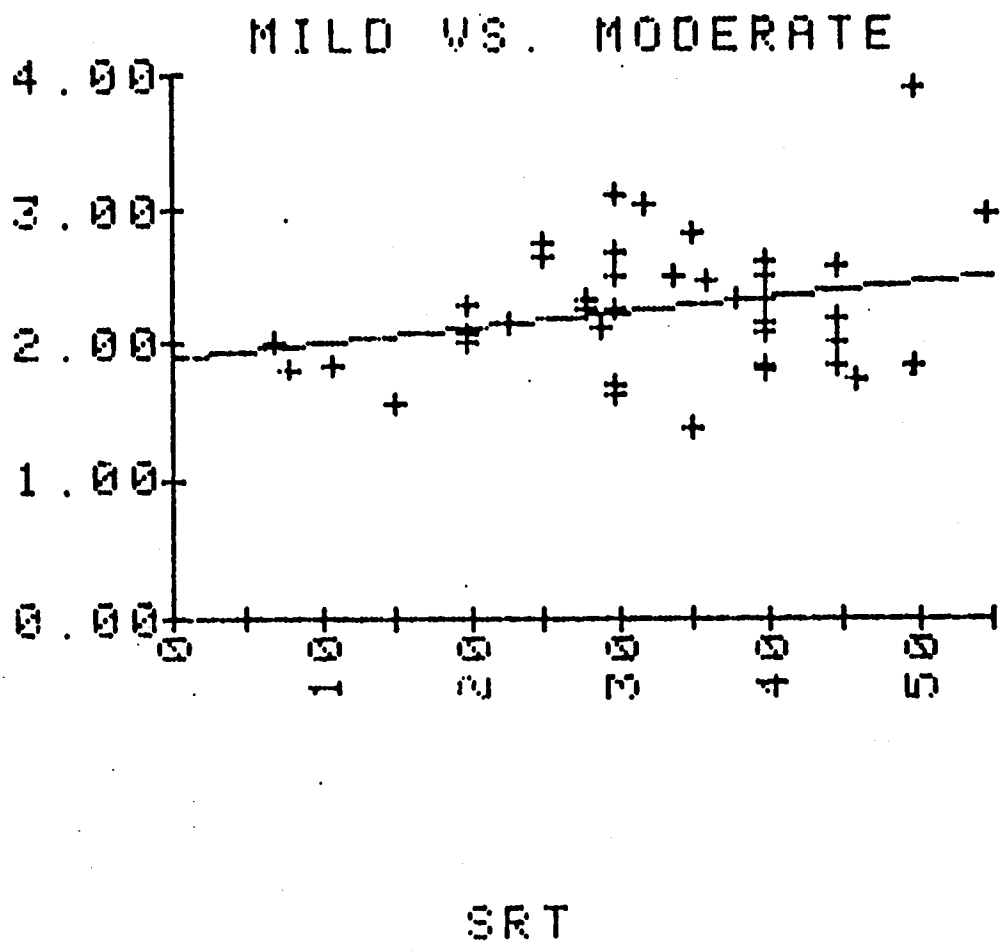

Figure 2b. Mild Vs. Moderate Loss

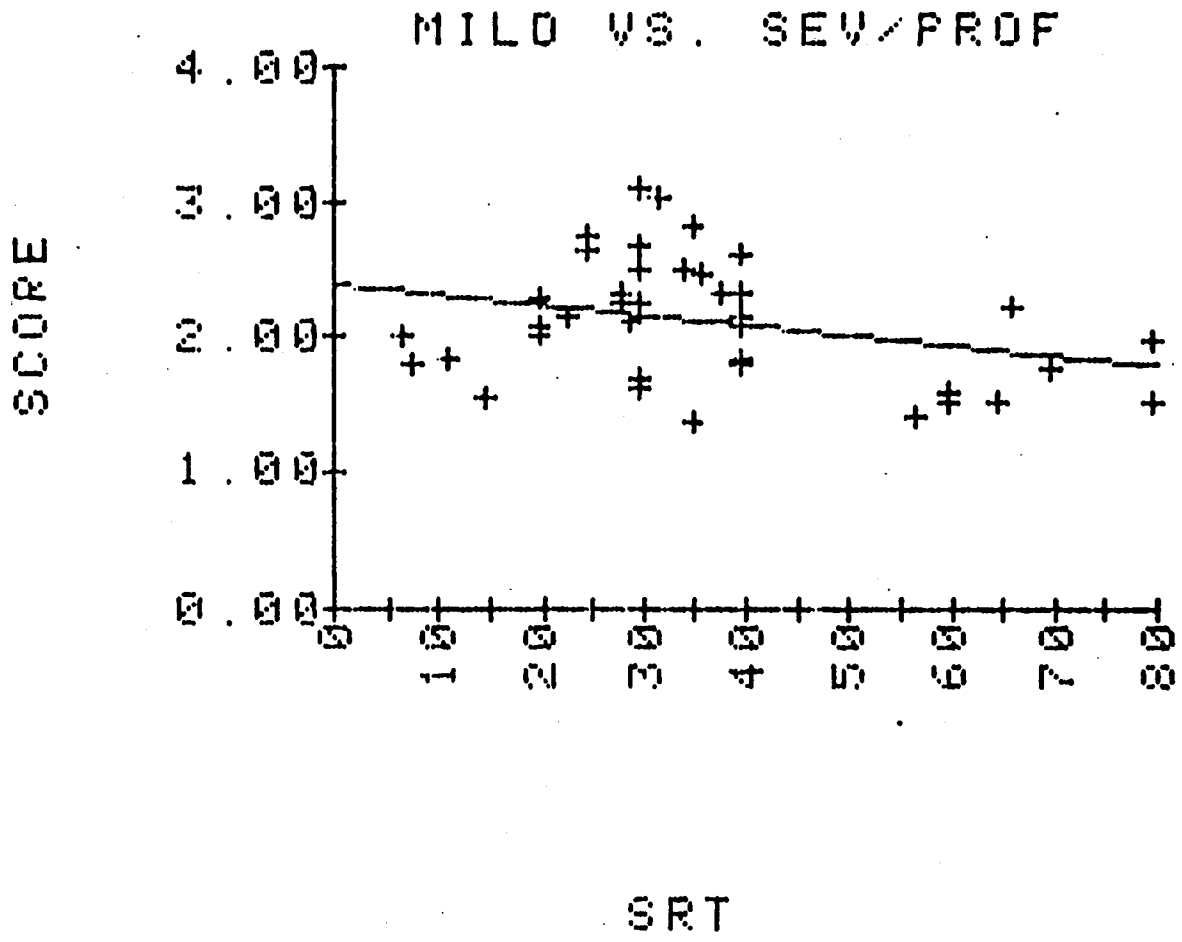

Figure 2c. Mild Vs. Severe to Profound Loss

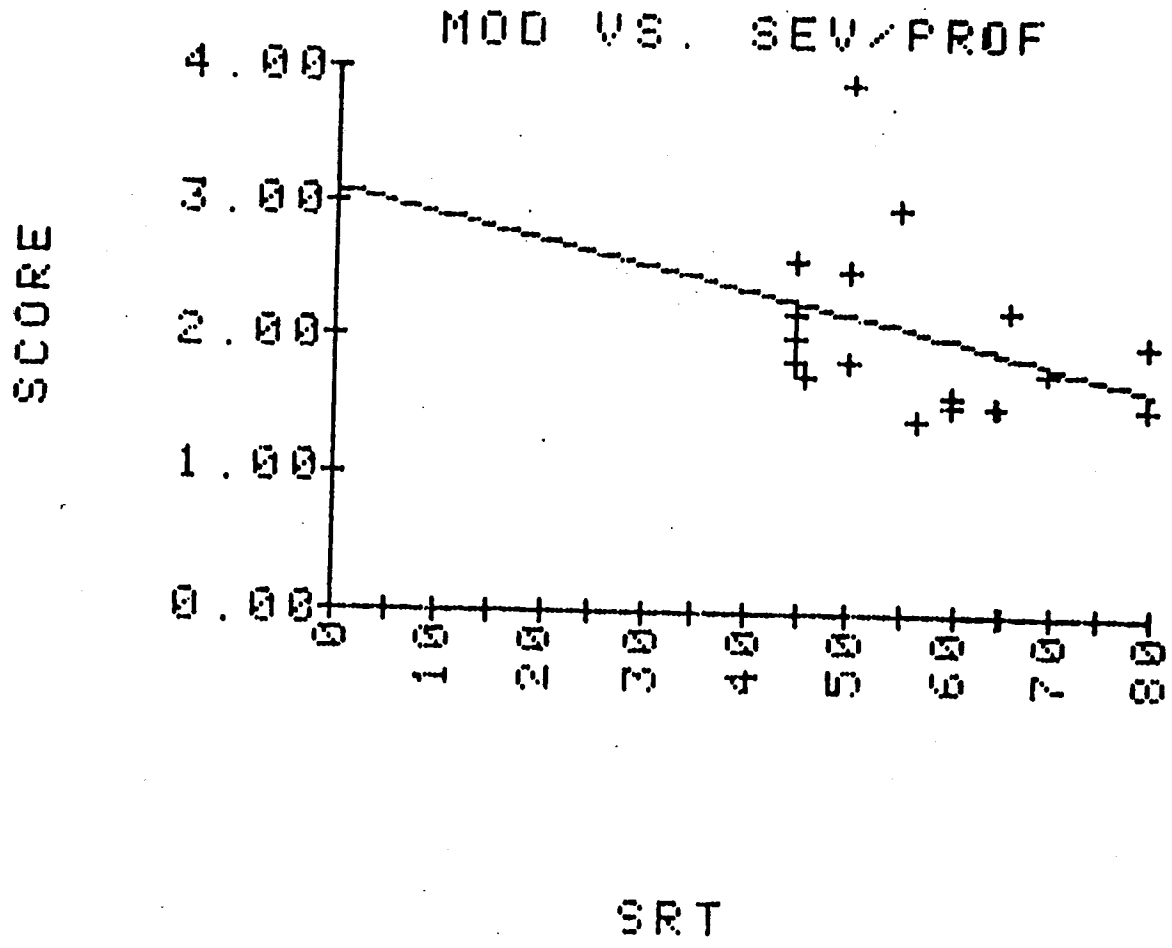

Figure 2d. Moderate Vs. Severe to Profound Loss

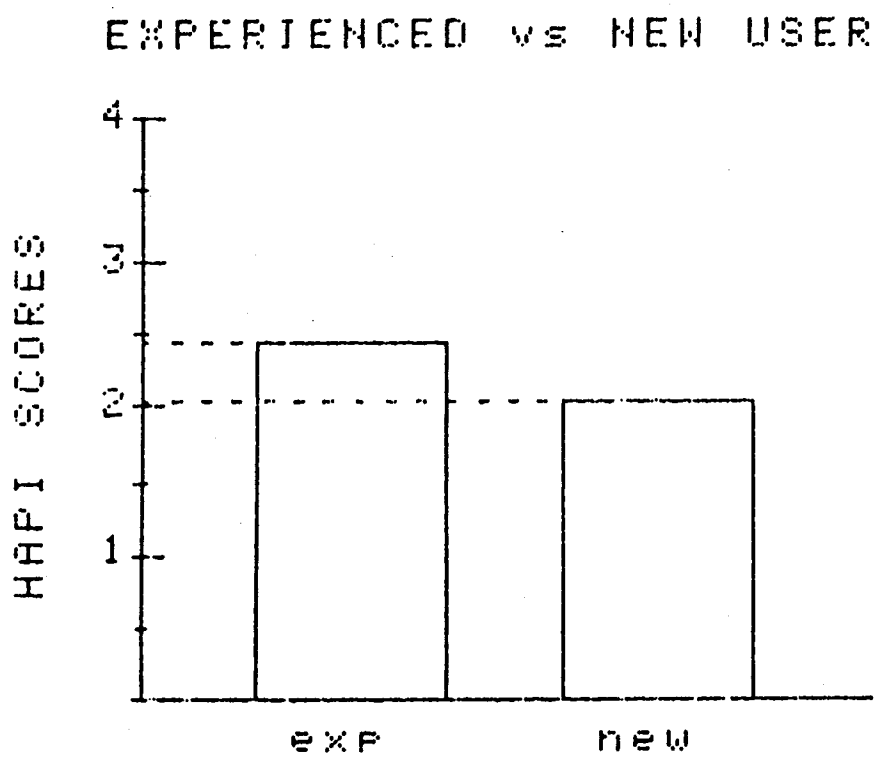

Figure 3a. HAPI Scores As A Function of Experience with Amplification

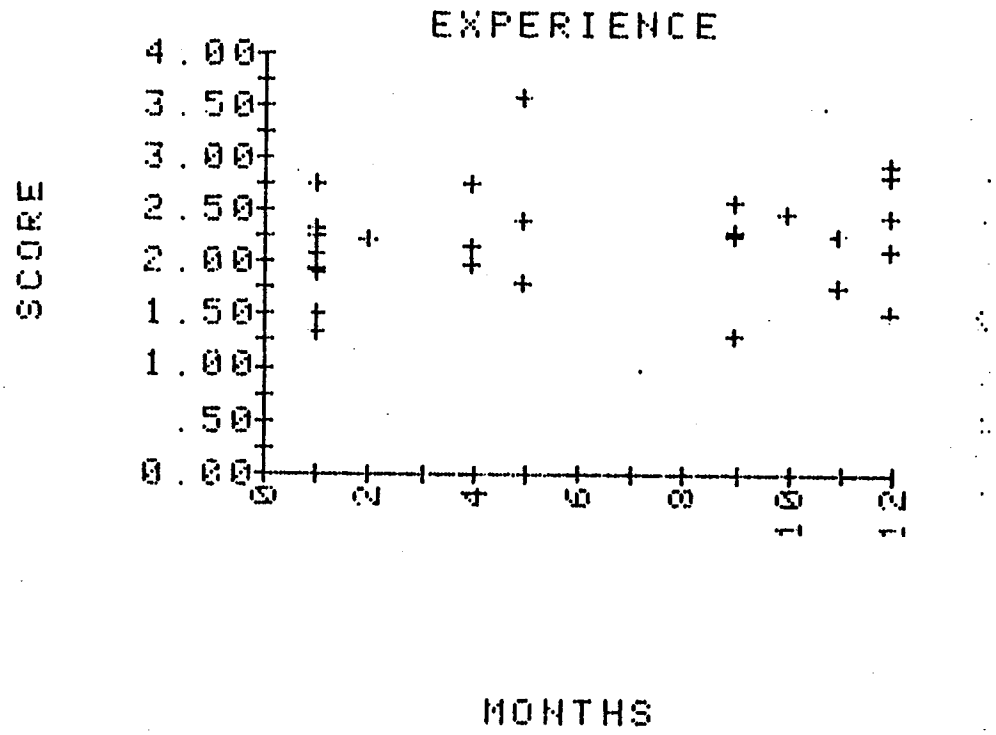

Figure 3b. HAPI Scores As A Function of Time Period with Aid before Administering of the HAPI

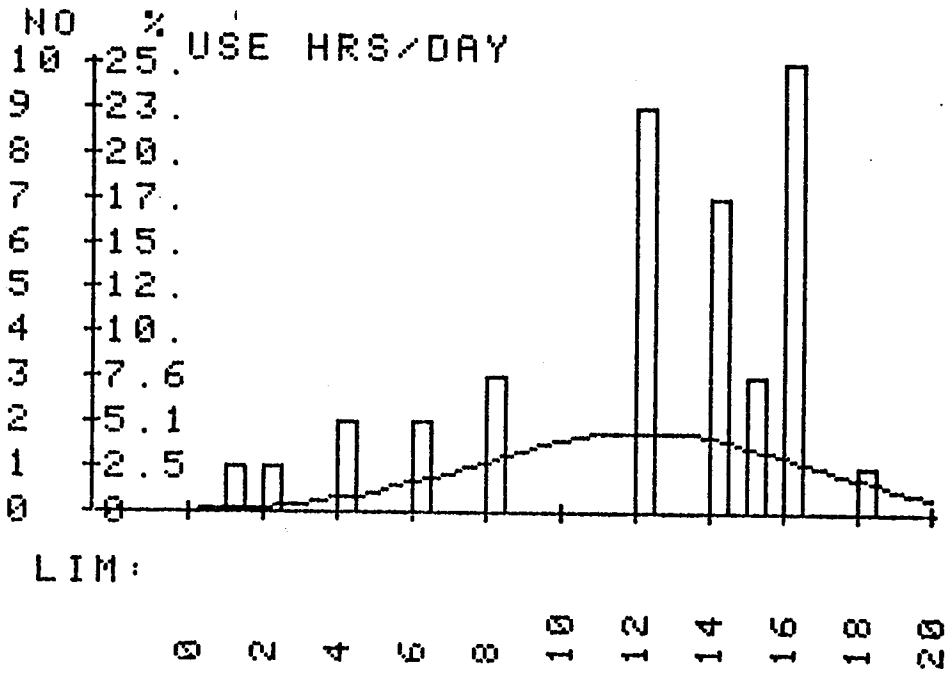

Figure 4. Distribution of Hearing Aid Use in Hours Per Day

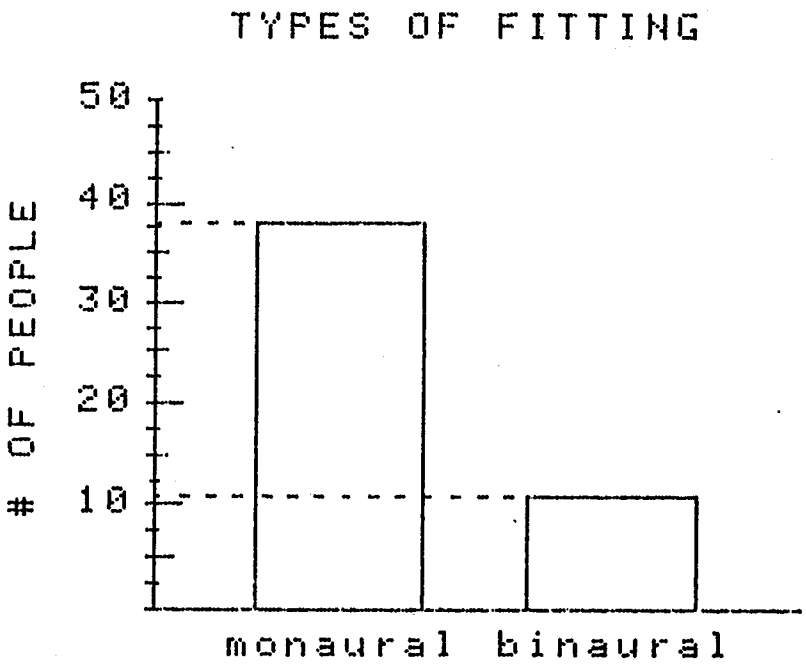

Figure 5. Number of Patients with Monaural vs. Binaural Fitting

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APPENDIX A

CETNRAL INSTITUTE FOR THE DEAF
818 SOUTH EUCLID
ST. LOUIS, MO 63110

THE HEARING AID PERFORMANCE INVENTORY

Instructions

Please complete the enclosed questionnaire and return it to us in the envelope provided. Your answers will assist us in our research, which is designed to improve hearing-aid-fitting procedures.

We are interested in knowing the extent to which your hearing aid helps you in your daily life. In this questionnaire you are asked to judge the helpfulness of your hearing aid in a variety of listening situations. You are to rate the benefit of your hearing aid in each situation, and not the difficulty of the situation itself.

To answer each question, check the phrase that best describes how your hearing aid helps you in that situation.

_____ Very helpful

_____ Helpful

_____ Very Little Help

_____ No Help

_____ Hinders Performance

There are items that appear similar but differ in at least one important detail. Therefore, read each item carefully before checking the appropriate phrase. We know that all people do not talk alike; some mumble, others talk too fast, and others talk without moving their lips very much. Please answer the questions according to the way most people talk.

If you have never experienced the situation but can predict your hearing aid performance, respond to the item. A "Does Not Apply" response box is also provided. However, use the response "Does Not Apply" only if you do not know how helpful your hearing aid would be in the given situation.

APPENDIX A (continued)

Items

1. You are sitting alone at home watching the news on TV.

2. You are walking in the downtown section of a large city. There are the usual city noises and you are in conversation with a friend.

3. You are riding in the back seat of a taxi. The windows are down and the radio is on. The driver strikes up a conversation in a relatively soft voice.

4. You are in a crowded grocery store check-out line and are talking with the cashier.

5. You are with your family at a noisy amusement park and are discussing which attraction to go to next.

6. You are taking an evening stroll with a friend through a quiet neighborhood park; there are the usual environmental sounds around (e.g., children playing, dogs barking, birds singing).

7. You are at home alone listening to your stereo system (instrumental music).

8. You are in the kitchen in conversation with your spouse during the preparation of an evening meal.

9. You are at home in face-to-face conversation with one member of your family.

10. You are shopping at a large busy department store and are talking to a salesclerk.

11. You are at church listening to the sermon and sitting in the front pew.

12. You are having a conversation in your home with a salesman and there is background noise (e.g., TV, people talking, etc.) in the room.

13. You are attending a business meeting where people are seated around a conference table. The boss is talking and everybody is listening.

14. You are talking with a friend outdoors on a windy day.

15. You are in a small office interviewing for a job.

16. You are talking with a teller at the drive-in window of your bank.

17. You are in conversation with a neighbor across the backyard fence.

18. You are in your backyard gardening. Your neighbor is using a noisy power lawnmower and yells something to you.

19. You are riding in a crowded bus and are in conversation with a stranger seated next to you.

20. You are driving with your family and are listening to a news broadcast on the car radio. Your window is down and family members are talking.

21. You are driving your car with the windows down and are carrying on a conversation with others riding with you.

22. You are in a large business office talking with a clerk. There is the usual office noise (e.g., typing, talking, etc.).

23. You are in a quiet conversation with your family doctor in an examination room.

24. You are walking through a large crowded airport and are in conversation with a friend.

25. You are at a large noisy party and are engaged in conversation with one other person.

26. You are at the dinner table with your whole family and are in conversation with your spouse.

27. You are attending a business meeting where people are seated around a conference table. The discussion is heated as everyone attempts to make a point. The speakers are frequently interrupted.

28. You are one of only a few customers inside your bank and are talking with a teller.

29. You are downtown in a large city requesting directions from a pedestrian.

30. You are driving your car with the windows up and radio off, and are carrying on a conversation with your spouse, who is in the front seat.

APPENDIX A (continued)

	Very Helpful	Helpful	Very Little Help	No Help	Hinders Performance	Does Not Apply
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
11.						
12.						
13.						
14.						
15.						

	Very Helpful	Helpful	Very Little Help	No Help	Hinders Performance	Does Not Apply
16.						
17.						
18.						
19.						
20.						
21.						
22.						
23.						
24.						
25.						
26.						
27.						
28.						
29.						
30.						

HEARING AID PERFORMANCE INVENTORY

NAME _____ AGE _____ DATE _____

ADDRESS _____ PHONE _____

SEX _____ MARITAL STATUS _____ EDUCATION _____ OCCUPATION _____

HEARING AID MAKE _____ MODEL _____ EAR: R___ L___ BOTH___ HRS OF USE PER DAY _____

HOW LONG HAVE YOU WORN A HEARING AID? YRS___ MONTHS___ PRIOR HEARING REHABILITATION COURSE _____

IF YES, WHEN _____ WHERE _____

Please complete the response sheet on the reverse side. When you have finished it would be very helpful if you would take the time to answer the questions below.

Describe those listening situations in which you find your hearing aid to be most beneficial.

Describe those listening situations in which you find your hearing aid to be least beneficial.

Other Comments:

APPENDIX A (continued)

APPENDIX B

BIPOLAR SITUATION FEATURES

1) Setting	Familiar Unfamiliar
2) Talker	Familiar Unfamiliar
3) Environment	Quiet Noisy
4) Distractions	Absent Present
5) Signal	Close Distant
6) Signal	Soft Loud
7) Signal	Speech Nonspeech
8) Masker	Soft Loud
9) Masker	Interrupted Steady
10) Location	Indoors Outdoors
11) Visual Cues	Absent Present
12) Speech	Live Reproduced

Adapted from Walden, 1982

Appendix C

TYPE OF LOSS

Sensorineural	Mixed/Conductive
N = 42	N = 8
mean score = 2.15	mean score = 2.07
std. dev. = .49	std. dev. = 55
Results of t test = t-.44	df = 48, p = .33

HAPI SCORES

Sensorineural	Mixed/Conductive
2.62	1.50
1.97	2.96
2.00	2.20
2.83	2.17
2.67	2.53
2.13	1.40
1.60	2.27
1.57	1.53
2.07	
1.36	
1.53	
1.79	
1.73	
2.23	
3.10	
1.83	
2.19	
1.55	
3.89	
1.61	
1.83	
1.69	
1.81	
2.69	
2.00	
2.11	
2.53	
2.34	
1.83	
2.27	
2.30	
2.34	
2.15	
2.10	
2.57	
2.00	
2.47	
2.33	
2.77	
1.82	
2.50	
1.76	

Appendix D

DEGREE OF HEARING LOSS

Mild Loss (SRT: 0-40)	Moderate Loss (SRT: 41-55)	Severe to Profound Loss (SRT: 56-90
N = 31	N = 9	N = 8
mean score = 2.23	mean score = 2.39	mean score = 1.69
std. dev. = .43	std. dev. = 69	std. dev. = .28

*Results of one-way analysis of variance: F = 5.4, P = .008

Results of t test, Mild vs. Moderate: t = .827 p = .207
Results of t test, *Mild vs. Severe to Profound: t = 3.36, DF = 37, p = .009
Results of t test, *Moderate vs. Severe to Profound: t = 2.66, DF = 15, p = .007

HAPI SCORES

Mild	Moderate	Severe-Profound
2.62	2.96	1.57
2.83	2.00	1.53
2.67	1.73	2.23
2.13	1.83	1.40
1.36	2.19	1.53
3.03	3.89	1.76
2.17	1.83	1.50
1.79	2.57	1.97
3.10	2.50	
1.55		
1.61		
1.83		
2.53		
1.69		
1.81		
2.69		
2.00		
2.10		
2.53		
2.34		
2.27		
2.27		
2.30		
2.34		
2.15		
2.10		
2.00		
2.33		
2.77		
1.82		
2.47		

*Significant beyond .05 level

Appendix E

EXPERIENCE WITH AMPLIFICATION

Experienced H.A. Users	First-Time H.A. Users
N = 15	N = 35
mean score = 2.46	mean score = 2.07
std. dev. = .60	std. dev. = .40

t test results: t = 2.89; p = .003

HAPI SCORES

Experienced Users	First-Time Users
1.50	2.62
2.96	2.20
1.97	2.00
2.83	2.13
2.67	1.36
3.03	1.57
2.23	2.07
2.19	1.53
3.89	2.17
2.53	1.79
1.81	1.73
2.00	3.10
2.57	1.83
2.00	1.55
2.77	1.61
	1.83
	1.40
	1.69
	2.69
	2.11
	2.53
	2.34
	1.83
	2.27
	2.27
	2.30
	2.34
	2.15
	1.53
	2.10
	2.47
	2.33
	1.82
	2.50
	1.76

Appendix F

HEARING AID USE

8 or less hrs/day	12 or more hrs/day
N = 9	N = 30
mean score = 2.32	mean score = 2.14
std. dev. = .43	std. dev. = .53

Results of t test: t = .95, df = 37, p = .17

HAPI SCORES

8 or less	12 or more
2.96	1.50
2.62	1.97
2.67	2.83
2.17	2.13
1.79	1.57
1.61	2.07
2.27	3.03
2.33	2.23
2.50	1.83
	1.55
	3.89
	1.83
	2.53
	1.40
	1.69
	1.81
	2.00
	2.11
	2.53
	1.83
	2.30
	2.34
	2.15
	1.53
	2.57
	2.00
	2.47
	2.77
	1.96
	1.76

Appendix G

MONAURAL VS. BINAURAL FITTING

Binaural	Monaural
N = 11	N = 38
mean score = 2.08	mean score = 2.20
std. dev. = .40	std. dev. = .54

t test results: t = .69, DF = 47, p = .25

HAPI SCORES

Binaural	Monaural
1.97	1.50
2.83	2.96
2.67	2.62
1.83	2.20
2.19	2.00
1.55	1.36
1.83	1.57
1.81	2.07
2.30	3.03
2.10	1.53
1.76	2.17
	1.79
	1.73
	2.23
	3.10
	3.89
	1.61
	2.53
	1.40
	1.69
	2.69
	2.00
	2.11
	2.53
	2.34
	1.83
	2.27
	2.27
	2.34
	2.15
	1.53
	2.57
	2.00
	2.47
	2.33
	2.77
	1.82
	2.50

Appendix H

PERCENT OF IMPROVEMENT OF ARTICULATION INDEX

N = 48* Mean % of AI Improvement = 37.63 Std. dev. = 18.87

% AI Improvement	HAPI Score	% AI Improvement	HAPI Score
83	1.53	33	1.73
78	2.83	29	3.89
70	1.97	29	1.82
69	1.50	28	1.61
67	1.40		
67	1.53	28	2.00
62	2.57	28	2.33
58	1.55	27	2.96
58	2.53	27	2.62
56	3.10	27	2.34
55	3.03	26	1.79
55	1.83	25	2.00
45	1.57	24	2.27
45	1.69	24	2.47
45	2.34	22	2.23
44	1.96	22	2.30
41	2.19	22	2.50
41	2.11	18	2.13
41	2.10	16	1.76
41	2.77	16	2.17
39	2.00	15	2.53
39	2.15	15	2.27
38	2.69	12	2.67
35	1.83	11	1.83
		10	2.0

*Missing data (2) due to lacking values for unaided AI.

Appendix I

PATIENTS' COMMENTS

SITUATIONS IN WHICH HEARING AID IS LEAST BENEFICIAL

Description	Occurrence
Situations with background noise	(28)
In crowds/more than one speaker	(20)
In car	(8)
Talking on telephone	(8)
When speaker's back is turned	(7)
In wind	(6)
Listening to high pitched sounds	(4)
At movie/theater	(3)
When speaker is at a distance	(3)
Listening to speaker with a soft voice	(3)
In church	(3)
TV or radio	(2)
At lectures	(1)

PATIENTS' COMMENTS (con't)

SITUATIONS IN WHICH HEARING AID IS MOST BENEFICIAL

Description	Occurrence
Face-to-face conversations	(21)
Watching TV	(20)
Quiet Setting	(14)
In church	(10)
Small groups/one person speaking at a time	(6)
In group meetings/several talking	(5)
Speaker at a distance	(4)
Speaker turned away	(4)
Hearing phone or doorbell ring	(3)
At movies/theater	(3)
Listening to music (especially high tones)	(2)
Talking on telephone	(2)
When listening in a classroom	(1)