

# **A Support System for Hearing Aid Evaluations**

JACLYN S. GAUGER

and

DAVID L. McPHERSON

*Department of Audiology  
Rochester Institute of Technology  
National Technical Institute for the Deaf  
Rochester, New York*

*An instructional package of eight books was developed and field tested for use with a population of 26 non-hearing aid users at the National Technical Institute for the Deaf (NTID). The content material consisted of: Hearing Aids and What They Do, Earmolds and Hearing Aid Batteries, Maintenance and Care of Hearing Aids, Troubleshooting Hearing Aid Problems, and Consumer Information. The results of using the materials for two academic quarters in an individualized setting are presented along with results of the hearing aid evaluations. Acceptance or rejection of amplification after long periods of non-use cannot be determined by a single factor, rather by a combination of didactic, functional, and motivational aspects of hearing aid use.*

It has been found that written information enhances the process of maximizing the transfer of information to a deaf population (Gates, 1971; Norwood, 1976; Panko, 1975). In addition, it has been found that effective use of personal amplification is often closely related to the individual's understanding of strategies, operation, and situational cues associated with the use of such devices. It is believed that by properly educating and counseling the individual, more effective use of amplification may be maintained. It is also realized that by the time a hearing impaired person reaches the chronological age (CA) of 14 to 23 years old, attitudes and habits relative to past experience with amplification may be well established. If individuals are not using their hearing aids "all or most-of-the-time" their chances of achieving maximum effectiveness with

amplification are drastically reduced (Johnson, 1974). Consistent with this, Walter and Sims (Note 1) indicate that "prolonged use of hearing aids can have a beneficial effect on the communicative skills of speech, speechreading and hearing discrimination of deaf, young adults." This was true regardless of levels of speech discrimination.

The question which this paper addresses is the need for a program in which students who have had little and/or negative experience in the use of amplification may be encouraged to attempt its use and base a decision of acceptance or rejection on communicative criteria and not on other factors which influence amplification acceptance as discussed above. Therefore, a course entitled "Orientation to Hearing Aids" (OHA) was established at the National Technical Institute for the Deaf (NTID). The original conceptual organization of the course was first reported by Galloway (1975).

The original course was developed in a traditional group lecture format supplemented by visual aids (slides, transparencies, and printed material). However, students were seen individually for hearing aid evaluation procedures concurrently with course lectures. The course lasted for ten weeks (one academic quarter). The need to modify the format was justified by observed boredom, inattention, attendance problems, and a lack of assimilation of academic material. Additionally, in a group situation, physical manipulation of the hearing aid by the student was difficult to monitor and evaluate. It was difficult to set a reasonable educational and rehabilitative pace for all students (especially those with varied past experiences).

A consultant in instructional development was asked to review the course in terms of objectives, task analysis, and media needs. It was agreed that an individualized approach utilizing a "workbook" format was most reasonable. The development of a prototype package involved a content specialist (audiologist), instructional developer, instructional programmer, artist/designer, and various other support personnel experienced in media production techniques. The instructional programmer (responsible for data collection and evaluation) maintained a close working relationship with the instructional developer to organize content and proper data collection procedures to evaluate and field test such a program. The artist/designer was responsible for the development of appropriate layout, graphics, and other artwork to enhance the learning aspects of the program. The content specialist worked closely with other faculty members in the Department of Audiology who served to critique the content based on their experiences in this area with NTID students. The approach to such a program, utilizing these professionals, was developed, and the curriculum produced.

## COURSE DEVELOPMENT

### *Population*

Students selected for this course were those who had been without amplification for at least three years prior to entrance into the course, and were willing to attempt to use amplification again. There were no specific audiometric criteria except those established by NTID. In general, students at NTID must have a pure tone average of 70 dB HL (ANSI, 1969) or worse in the better ear. Approximately 20 % of students entering NTID in the summer of 1976 were eligible for this course. During the ensuing 1976-1977 academic year, 36 students completed Orientation to Hearing Aids (OHA).

### *Course Objectives*

The terminal objective of the OHA course at NTID is for each student to accept long-term use of wearable personal amplification. In order to facilitate this goal, three levels of functioning are desired, each level having its own objective.

1. *Cognitive*: After completing five modules of instruction, the student will a) list the parts of a hearing aid and their functions, and b) properly fill out guarantee and service plan (insurance) forms. The criterion level is 80% on a written test. Additionally, given an actual hearing aid and attachments, the student will be able to correctly identify the parts.
2. *Psychomotor*: After completing five modules of instruction and 6-10 hours of hearing aid evaluation procedures, the student will a) appropriately adjust the controls of the hearing aid selected for use, and b) demonstrate maintenance and trouble-shooting procedures of all facets of hearing aids. These demonstrations will be evaluated by the use of a performance checklist, which will be described later in this paper. One hundred percent competency is expected for all skills, although numerous opportunities are available to reach the competent level.
3. *Affective*: After completing the OHA course, the student will demonstrate appreciation of the importance of the aid as a means of improving the communication situation and/or listening environment. This is measured by short and long term student reports of hourly hearing aid use and by selected faculty who document the student's use of the aid during subsequent quarters.

### *Content*

In order to encourage understanding, acceptance, and long-term use of amplification, it was determined that the student needs to know the

basics of hearing aid structure, function, maintenance, troubleshooting procedures, and consumer information, preferably in a printed format. This has been stressed most recently by Kasten and Warren (1977).

The total OHA instructional package contains eight books:

1. *Student Manual*—The Student Manual is the course guide given to each student at the beginning of OHA which outlines the course, its policies, rationale, grading, and other details which help the student understand what to expect from OHA. A take-home test on the material in the Student Manual is included in an effort to insure that it is read.
2. *Audiologist Manual*—The Audiologist Manual is an instructor's guide which contains the course objectives, description, and suggestions for using the package so that an audiologist may fully understand and teach the course without an inordinate amount of additional training.
3. *Books 1-5*—These are instructional books, written at approximately a seventh grade vocabulary level, utilized to support the hearing aid evaluation process.

Hearing Aids and What They Do/1

Earmolds and Hearing Aid Batteries/2

Maintenance and Care of Hearing Aids/3

Troubleshooting Hearing Aid Problems/4

Consumer Information: Hearing Aids/5

Each of the five instructional books contains the following:

1. introduction to the book
  2. objectives
  3. vocabulary words and definitions
  4. content presentation and self-quizzes
  5. plan for next meeting with instructor
  6. performance checklist activities
4. *Hearing Aid Record*—The Hearing Aid Record is a record keeping device for the instructor and the student which contains information specific to each hearing aid which is loaned. The instructor records a complete description of the 'loaner' hearing aid, and the student answers questions and describes appropriate reactions to the loaner hearing aid. This book is utilized directly in the weekly hearing aid evaluation sessions. Student responses are discussed at each session at which time the student may expand upon the responses and draw comparisons with other loaner hearing aids.
  5. *Packaging and Achievement Stickers*—A slip case is provided to hold each student's instructional books, Student Manual, and Hearing Aid Record. A series of stickers are affixed to the slip case cover

to record the student's progress through the course.

#### USE OF CURRICULUM

The student meets individually with the instructor twice a week for 50 minutes per session. One session is devoted to the instructional books. The other session is devoted to the hearing aid evaluation. The above class meetings are not strictly limited to one area or the other, due to their mutually reinforcing natures. There is overlap and flexibility.

Since the focus of this paper is on the instructional books, their utilization will be described first. As mentioned previously, the Student Manual is distributed at the first meeting. The completed take home test is due at the following meeting (80% correct to meet criterion). The student is continuously reminded of, and referred to the information contained in this manual. The pre-test of all the information in the five books is then administered as a measure of prior exposure to the material. A score of 80% or better for any one book exempts the student from the post-test on that book, although not from the Performance Checklist activities.

Hearing Aids and What They Do/1 is given to the student at the next meeting (which is usually the same day as the first Hearing Aid Evaluation session) to read and study. The general format is explained using that book as a model. Certain points are highlighted, such as the objectives, the self-quizzes, the post-test, and what can be expected to occur the following week. The student is encouraged to read and study outside of class and to write any notes, questions, or comments based upon the reading material.

One week later, the classroom meeting involves the instructor answering questions the student may have regarding the book or related material. The self-quizzes are checked for completion and accuracy. The written post-test is administered and graded. This test is the same as the pre-test, except it is limited to the information in the specific book under consideration. If a grade of 80% or greater is earned, the errors are explained to the student and the corresponding Performance Checklist items are demonstrated by the instructor and/or attempted by the student. The Performance Checklist is a 27-item list of psychomotor skills which have been chosen as those basic to a successful hearing aid user. The student must perform each skill with 100% accuracy in order to pass it. Table 1 lists the items on the Performance Checklist.

If a grade of less than 80% is earned on the post-test, the instructor informs the student of the weak areas and suggests those parts of the book on which to concentrate during the following week. The instructor and student then agree to a new date for the post-test to be repeated (usually a

Table 1.

Performance Checklist

(100% accuracy is required in order to meet criteria)

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Hearing Aids and What They Do/1

1. Insert earmold
2. Attach earmold to hearing aid
3. Insert earmold with aid attached
4. Adjust volume control for MCL<sup>1</sup>
5. Name outside parts and controls

Earmolds and Hearing Aid Batteries/2

6. Wash mold with correct medium (given choice of 3)
7. Choose correct battery for current loaner aid
8. Test battery
9. Insert battery correctly
10. Know how to use recharger (if applicable)

Maintenance and Care of Hearing Aids/3

11. Turn switch to '0' when putting aid on and taking it off  
(or open battery case or turn volume control off)
12. Know when tubing should be replaced
13. Clean battery with eraser

Troubleshooting Hearing Aid Problems/4

14. Identify problems:
  - a. Broken hook
  - b. Dead battery
  - c. Weak battery
  - d. Battery in upside down

Table 1 cont'd

- e. Inappropriate battery size
- f. Hole in tubing
- g. Cracked case
- h. Frayed cord (if applicable)
- i. Plugged earmold opening

Consumer Information: Hearing Aids/5

- 15. Contact with VR counselor; one is required as proof
  - a. Copy of letter to VR
  - b. Written account of phone call
  - c. Letter from VR counselor to instructor
- 16. Fill out guarantee form; know when it ends and what it covers
- 17. Fill out own service plan form (if applicable); know when it ends and what it covers

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<sup>1</sup>Most comfortable (listening) level.

week later). If the student feels (and the instructor agrees) that the unsatisfactory score was due to lack of studying, and not lack of understanding, then no further explanations or clarifications may be required. However, if the problem is due to lack of understanding of the written text, basic concepts, or vocabulary, then the instructor explains, in detail, the information with which the student had difficulty. This is done by using examples, real objects, demonstrations, and/or alternative teaching strategies. The post-test is administered and the process repeated until the student meets the 80% correct criterion.

In the above case, the items on the Performance Checklist may be instructor-demonstrated, or if the instructor feels that the student may experience success with the items, asks for student demonstrations. A student may not be successful with an item and still move on to the next book providing the unsatisfactory items are all re-checked until they are completed satisfactorily. The items on the Performance Checklist are reinforced during the Hearing Aid Evaluation sessions.

Once a post-test is successfully passed, the next book is given to the student. Each book aims for a one week completion period. In exceptional cases, an instructor may decide to test a student earlier based on

previous competency, time constraints, and extreme student motivation. The sequence continues as above, the books alternating with Hearing Aid Evaluation sessions until the student completes the course (meets course objectives) and makes a decision regarding amplification.

### HEARING AID EVALUATION

The Hearing Aid Evaluation (HAE) meeting is spent testing the student's performance (as described below) with a variety of hearing aids and modifications in order to determine an appropriate loaner instrument. A loaner instrument is one which both student and instructor feel they want more information about and has the potential to be a 'good' choice. The student borrows the hearing aid for the week between HAE appointments. The student is encouraged to wear the hearing aid as often as possible and in a variety of situations in order to answer questions about the hearing aid in the Hearing Aid Record.

A week later the meeting with the instructor involves discussion, more evaluation of hearing aids, possible modifications and/or change of hearing aid fitting as a result of the discussion and evaluation. This process is repeated until both student and instructor reach a decision about the benefits and long-term use potential of a particular hearing aid fitting. If the student decides, after a minimum of six weeks in the course, that long-term all or most-of-the-time hearing aid use is inappropriate, and if the instructor feels that the student has sufficient evidence to make that decision, the student is essentially finished with the hearing aid evaluation portion of the course. No student is forced to accept a hearing aid. This fact is made clear to all students at the beginning of the course. The option is always left open for the student to return at a later date for a continuation of the hearing aid evaluation.

If the student decides to purchase a particular hearing aid for all or most-of-the-time use, and if the instructor finds that the fitting is the best one possible for that student, the hearing aid evaluation is completed, and payment procedures are worked out. Most students request financial support from their state Vocational Rehabilitation agencies.

#### *Procedures*

The initial Audiometric Assessment completed in the summer is acceptable if it is less than six months old at the start of OHA. It includes pure tone audiometry, tympanometry, and hearing discrimination measures. Two to three moderate to high gain flexible hearing aids are chosen and evaluated with a variety of settings—usually beginning with a "normal" (flat) frequency response, no output limiter, and modifying the tone and power controls according to test results and student comments.



*Most Comfortable Level (MCL).* The student adjusts the volume control outside of the test suite as the instructor talks to insure that the student can manipulate the volume control and understands its effects by experiencing the intensity changes. This manipulation is then required for MCL measures while listening to a sentence recorded by a male speaker several times, presented at 50 dB HL. The student is instructed to find the "best, most comfortable setting for listening"—even if the speech cannot be understood. A bracketing technique is used and three consecutive MCL's within a 10 dB range are averaged to calculate the MCL.

*Uncomfortable Listening Level (UCL).* Once the comfort (MCL) setting is established, the student is instructed not to change the setting for the duration of the HAE. The UCL for speech is then determined, and is defined as the level at which speech begins to 'bother' the student (i.e., excessive loudness or pressure, itching, onset of audiokinetic nystagmus). The same recorded sentence is used as for MCL. An ascending technique is used and once two out of three UCL responses at the same intensity level have been observed, in that level is recorded as the student's UCL.

The difference between MCL and UCL is defined as the dynamic listening range and is used as a comparative measure. In general, most students who have at least a 20 dB difference between MCL and UCL for speech do not complain of sounds bothering them during the subsequent loan period. Comfort is one of the important criteria which has been used in determining hearing aid selections for this population.

*Speech Awareness Threshold (SAT).* The SAT is established with the volume control set for MCL. The student is then instructed to respond whenever a voice is audible, regardless of its intensity. An ascending technique is used, and three responses are averaged to calculate the SAT.

*Narrow Band Noise Measures.* Threshold measures are collected utilizing sound field narrow bands of noise centered at octave and/or half-octave intervals for .5 kHz through 4.0 kHz (.25 kHz is added if the instrument being evaluated is body-borne or has an extended low frequency response). A bracketing technique is utilized. Narrow bands of noise are also used to gather discrete frequency MCL and UCL information. The methods of determining MCL and UCL are similar to those described above to determine MCL and UCL for speech stimuli. When a small difference between MCL and UCL is noted at any one or all frequencies, the instructor begins to change the frequency response and output characteristics of the instrument. In order to determine the actual output of the hearing aid to the student's ear at the test frequencies, the aid is placed in a hearing aid test chamber without changing the volume control from the comfort setting. The same intensities used for the HAE are duplicated in the hearing aid test chamber. These intensities are those that were used to establish MCL and UCL at the respective test frequen-

cies. All SPL outputs are recorded, and UCL minus MCL differences are observed. The instrument (or a different instrument) is then adjusted to best approximate, but not exceed, UCL's. Additionally, a frequency response curve is obtained at the same intensity as the MCL response. Extremely small differences between MCL and UCL at one or more frequencies are noted. Manipulation of tone controls, power controls, and compression controls as well as lamb's wool and a variety of other filters have been used to alter the response and output characteristics of a particular hearing aid.

Once a 'loaner' hearing aid selection is determined, the instructor completes the appropriate portion of the Hearing Aid Record and gives it to the student. The student has subsequent assignments to complete by the end of the one week loan period. If the student has difficulty before the end of the week, informal contact can easily be made with the instructor.

*Hearing (Speech) Discrimination.* In order to describe the varied levels of hearing discrimination among NTID students, the NTID Profile System was developed (Johnson, 1976). Hearing Discrimination profile ratings from I (weakest skills) to V (strongest skills) (see Table 2) are

Table 2

Rating system and functional descriptors utilized by NTID  
for defining student hearing discrimination ability  
(Johnson, 1976 with permission).

Profile Rating	Functional Descriptor
5	Student understands the complete message
4	Student understands most of the content of the message
3	Student understands, with difficulty, about half of the message (understanding may improve with increased exposure)
2	Student understands little of the content of the message, but does recognize a few isolated words or phrases
1	Student cannot understand any of the message

obtained after a series of listening tasks are administered to the student. The test series begins at a profile III level. Profile III students successfully complete a 10-item closed set spondee discrimination task (minimal criterion for passing is 10/20 correct identifications). Students at a profile III level score between 0% and 49% of the key words correct on a list of ten CID everyday sentences (CHABA). The CHABA scores for profile IV are 50-89% of the key words correct, and for profile V are 90-100% of the key words correct. For students who have not successfully completed the spondee discrimination task, testing becomes less descriptive. A profile II rating involves successful completion of a spondee same-difference task (minimal criterion for passing is 15/20 items correct). A student who cannot pass the same-difference task, is at a profile I level. These measures do not appear sensitive enough to differentiate among hearing aids with students at the profiles I and II levels, and low profile III levels in hearing discrimination. However, used as a final measure of hearing discrimination functioning in an ideal listening environment, the profile can provide a baseline skill level, as well as a useful tool in counseling students as to realistic expectations from amplification.

## RESULTS

### *Field Test*

A total of 36 students have completed the course of instruction as described in this paper. The field test is based upon experience with 26 of the 36 students. All students took a pre-test of information presented in books 1 through 5. The highest pre-test mean score was obtained for book 3, and the lowest mean pre-test score was obtained for book 1 (Table 2).

Table 3 summarizes the post-test results. Mean post-test results for books 1 and 5 had the largest percentage of students repeating that material in order to reach the accepted criterion level. The mean final post-test score for all students on all books was 91%. The lowest mean post-test score (86%) was scored for book 4. One student failed to reach passing criteria, even upon repeated attempts of the material, for books 2 through 5. The average number of repeated post-tests per book was 2.1.

Following a minimum of one week exposure to the material, pre/post-test gain, as measured by an identical test, was 60 percentage points. The mean gain reflects the highest post-test score if the student was unable to meet the criterion level following completion of the previous test (Table 4).

Figure 1 shows the pre/post-test results and the results of the retention tests (N=5) for each of the five books. A complete set of post-tests was administered at the end of the course and six months later. Scores were

Table 3  
Measures of Prior Exposure Achievement (N=26)

Book	Mean pre-test score	Students passing pre-test ( _ 80%)
Hearing aids and what they do/1	19%	0
Earmolds and hearing aid batteries/2	28%	0
Maintenance and care of hearing aids/3	41%	1 <sup>a</sup>
Troubleshooting hearing aid problems/4	34%	1 <sup>b</sup>
Consumer information: hearing aids/5	33%	0
1-5	31%	2

<sup>a</sup>This student used a hearing aid before for 3 years.

<sup>b</sup>This student had the longest previous experience of all students.

significantly lower for book 1 on the second retention test than on the first retention test. There appears to be no significant difference in the retention tests for the remaining four books (books 2 through 5). This demonstrates that the material was retained at an acceptable level. Some individual students fell below the 80% criteria. However, this was predominantly for book 1.

The students' skill levels on the Performance Checklist items demonstrated that the skills which gave the most difficulty to the largest number

Table 4

Percent of Students Passing Post-Test  
Criteria for Each Book  
(N=26)

Book	% Repeaters <sup>a</sup>	Mean # of attempts <sup>b</sup>	# Students failing criteria	Mean final post-test score
Hearing aids and what they do/1	35	2.2	0	91
Earmolds and hearing aid batteries/2	16	2.0	1	94
Maintenance and care of hearing aids/3	17	2.0	1	89
Troubleshooting hearing aid problems/4 <sup>c</sup>	17	2.2	1	86
Consumer information: hearing aids/5 <sup>c</sup>	30	2.0	1	93
1-5	23	2.1	1	91

<sup>a</sup> Includes students who passed pre-test as non-repeaters.

<sup>b</sup> Mean # of attempts for the repeaters to meet criteria.

<sup>c</sup> 1 student could not be counted for books 4 and 5 because of time constraints. He is the only student failing criteria.

of students were: attach earmold to hearing aid, name outside parts and controls, test battery, know how to use the battery recharger, know when tubing should be replaced, and clean the battery with an eraser. Most of the other skills were performed with 100% accuracy by the end of the course.

Table 5  
Range and Mean of Pre/Post Test Gains (N=26)

Book	Mean gain in percentage points	Range of gain in percentage points
Hearing aids and what they do/1	73	36-97
Earmolds and hearing aid batteries/2	66	39-100
Maintenance and care of hearing aids/3	53	0 <sup>a</sup> -88
Troubleshooting hearing aid problems/4	51	0 <sup>a</sup> -91
Consumer information: hearing aids/5	58	26-100
1-5	60	

<sup>a</sup>Passed pre-test; pre-test score served as post-test score.

### *Student Population*

The average pure tone audiograms for ears which accepted hearing aids and for ears which did not are shown in Figures 2 and 3 respectively. There was no demonstrable difference between the two sets of audiograms. Pure tone results were then reported in a series of histograms (Figure 4) which were constructed based upon pure tone thresholds. There was no consistent relationship between pure tone thresholds, audiometric configurations, or frequency distribution and acceptance of amplification. There was a higher rate of non-acceptance when thresholds in the mid-to-high frequencies were poorer than thresholds in the low-to-mid frequencies. However, based upon Figures 2 and 3 this is not unexpected.

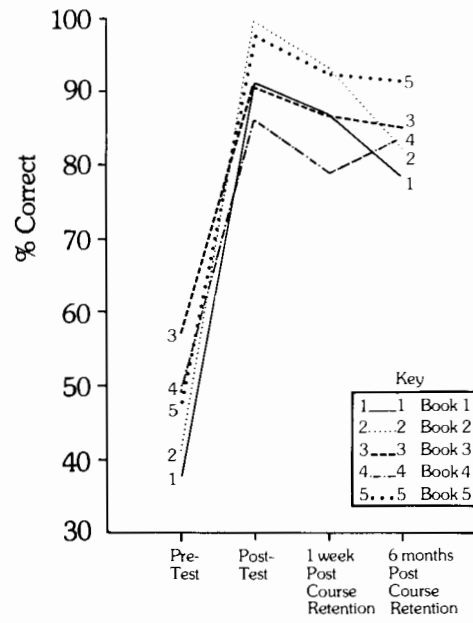


Figure 1. Pre/Post and retention test score comparisons for books 1-5.

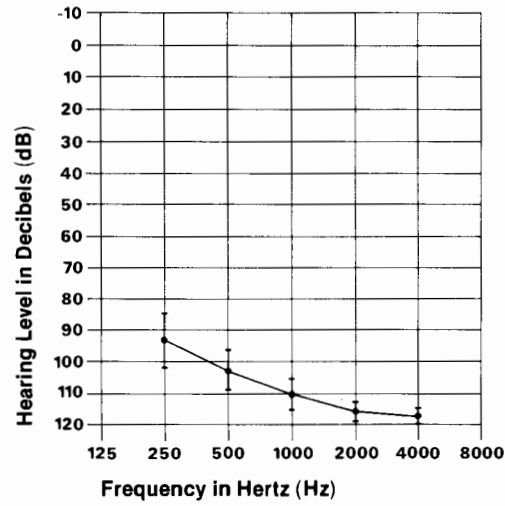


Figure 2. Mean audiogram for ears not accepting hearing aids.

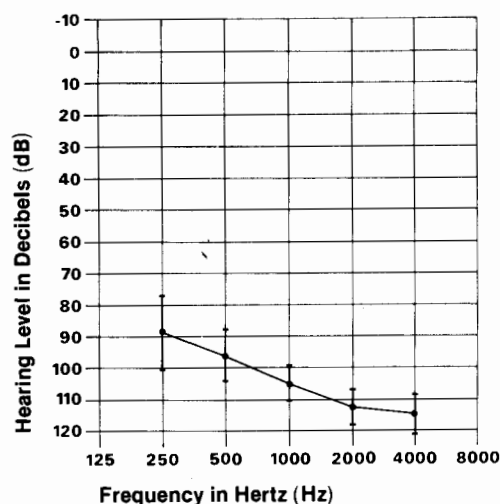


Figure 3. Mean audiogram for ears accepting hearing aids.

Figures 5 and 6 show mean audiograms of three cut-off frequency groups for those ears not accepting amplification, and those ears accepting amplification, respectively. Individuals with cut-off frequencies of 4 to 8kHz or higher, and those with cut-off frequencies of 1.0 kHz or lower, consistently accepted amplification (13 out of 14). Those individuals with cut-off frequencies of 1.5 to 3 kHz, that is the low-to-mid frequencies, had a poor acceptance rate (7 out of 12).

Table 5 shows the hearing discrimination profile levels of ears accepting hearing aids and ears not accepting hearing aids. The greatest number of hearing aids was placed on those individuals demonstrating a profile level III in the aided ear. The other extreme was profile level I in which 68% did not accept amplification. Ninety-two percent of the students fell within profile levels I and II. Students with profile levels IV and V did not meet criteria for acceptance into this course. This information was broken down into ears as opposed to individuals in order to see if there was a relationship between audiometric results and the acceptance of amplification. All individuals were considered 'potential' candidates for binaural amplification. The number of individual students accepting amplification at the end of the course is 20 out of 26.

The MCL and UCL levels for ears accepting amplification and ears not accepting amplification is summarized in Table 6. There appears to be no significant difference for either population of ears. Likewise, the dynamic range (usable range of hearing) although markedly reduced for both groups, revealed that there was no significant difference between those ears accepting amplification and those ears not accepting amplification.



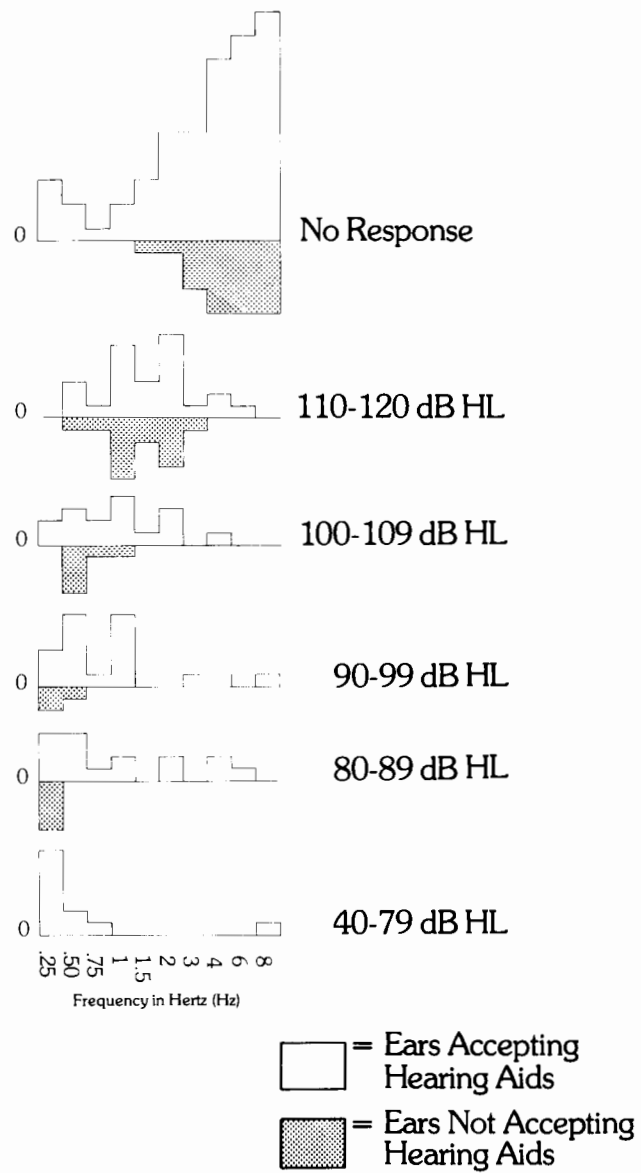


Figure 4. Histograms for six pure tone threshold groups differentiating acceptance vs. non-acceptance of amplification.

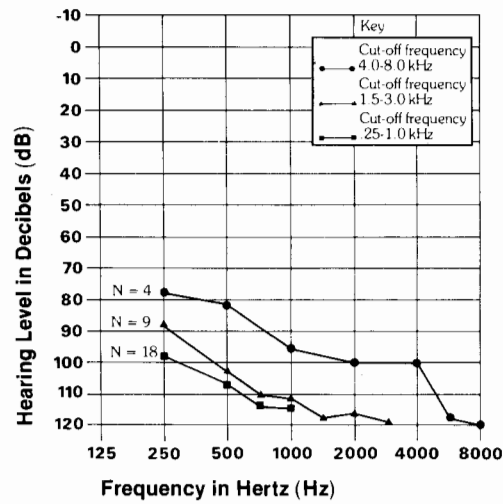


Figure 5. Mean audiograms for ears *not* accepting hearing aids for three cut-off frequency groups.

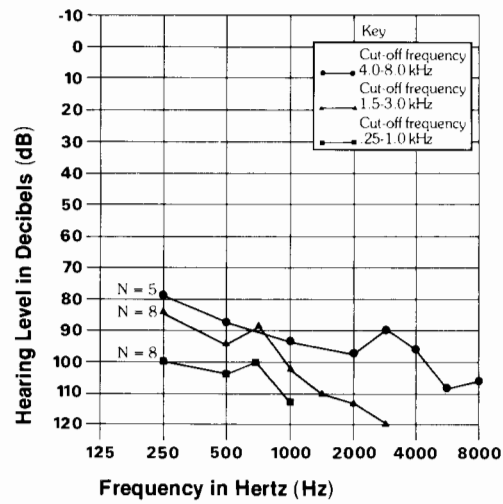


Figure 6. Mean audiograms for ears accepting hearing aids for three cut-off frequency groups.

Table 6

Hearing Discrimination Profiles of Ears Which  
Accepted Aids and Those Which Did Not (N=52 ears)

Profile	Did not		Total
	Accepted aid	Accept aid	
I	8 (32%)	17 (68%)	25 (48%)
II	10 (43%)	13 (57%)	23 (44%)
III	3 (75%)	1 (25%)	4 (8%)
IV	---	---	---
V	---	---	---
Total	21 (40%)	31 (60%)	52

Table 7

Most Comfortable Levels and Uncomfortable  
Levels of Ears Accepting and Ears Not  
Accepting Amplification (Under Earphones) (N=52 ears)

Condition		MCL	UCL	UCL-MCL
Accepted aid (N=21)	$\bar{X}$	96 dB HL	103 dB HL	7 dB HL
	<u>S.D.</u>	8.86	7.51	5.68
Did not accept aid (N=31)	$\bar{X}$	99 dB HL	104 dB HL	5 dB HL
	<u>S.D.</u>	8.38	7.72	4.53

Twenty-six students were seen during the Fall and Winter quarters of 1976 and 1977 in the Orientation to Hearing Aids course. Twenty-two students had some experience using hearing aids prior to entrance into this course. At the end of the course, 20 students accepted hearing aids. Four of the 26 students had no previous experience with hearing aids prior to enrollment at NTID. Three of the four students (75%) accepted amplification at the end of the course. Five students having prior experience rejected amplification; two of the five students' clinical test results did not contraindicate amplification usage. The remaining three students were not recommended for amplification by the audiologist because of severe audiokinetic nystagmus (an extensive research project is in progress to investigate audiokinetic nystagmus).

There does not appear to be any strong relationship between the age of onset of hearing aid usage, or years of usage that directly influences acceptance or rejection of amplification. The mean length of use of amplification prior to entrance to NTID was seven years. However, it is not possible to completely rule this out as a contributing factor. This is especially true in view of the suggestion that there is a relationship between previous amplification usage and acceptance of new amplification. However, none of these students were current hearing aid users. The mean length of non-use prior to entering NTID was nine years.

Figure 7 shows the mean frequency response curves of the hearing aids recommended for the three cut-off frequency groups (.25 kHz - 1.0 kHz;

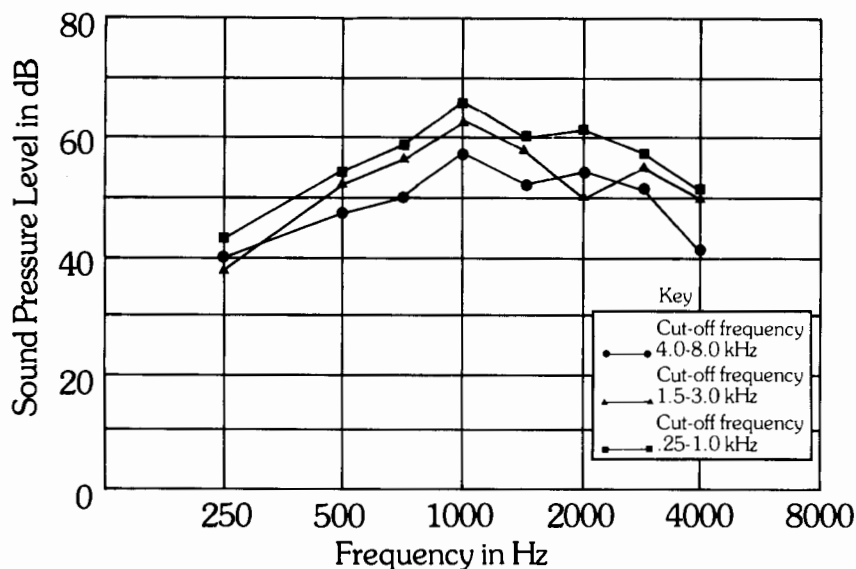


Figure 7. Mean B & K results of hearing aids fitted on three cut-off frequency groups.

1.5 kHz - 3.0 kHz; and 4.0 kHz - 8.0 kHz). There do not appear to be any major differences in the mean responses. Analysis of individual responses is presently under investigation.

There is no evidence to suggest that there are differences among the three cut-off frequency groups for the amount of gain or the maximum power output (M.P.O.) of the hearing aids recommended for the students (Table 7). Continuing analysis of the gain and M.P.O. data with a greater number of students is in progress.

It was an important consideration, in the development of this curriculum, to structure it such that the student gains maximum information from the instructional materials. Consequently, the materials were directed at levels consistent with the student's vocabulary, reading comprehension, and writing levels as determined by portions of the California Reading Test and the NTID Written Language Test (Walter, 1976;

Table 8

HAIC Gain and M.P.O. of Hearing Aids  
Fitted on Three Cut-Off Frequency Groups (N=15)

Cut-Off frequency		HAIC gain	M.P.O.
.25 - 1.0 kHz (N=6)	$\bar{X}$ <u>S.D.</u>	59 dB SPL 5.20	130 dB SPL 3.18
1.5 - 3.0 kHz (N=6)	$\bar{X}$ <u>S.D.</u>	59 dB SPL 6.01	125 dB SPL 4.35
4.0 - 8.0 kHz (N=3)	$\bar{X}$ <u>S.D.</u>	53 dB SPL 12.70	118 dB SPL 11.37
All students	$\bar{X}$ <u>S.D.</u>	58 dB SPL 7.20	125 dB SPL 7.08

Crandall, Note 2). There was no significant difference between the English levels of students registered for this course and the levels of all students entering NTID. Consequently, this factor was not considered to be a variable in the acceptance or non-acceptance process.

#### DISCUSSION

It is not possible to cite any single item, with respect to the hearing aid evaluation/fitting procedure, as a predictor for acceptance or rejection of amplification. This is not to say that the individual selection procedure does not contribute to eventual acceptance, but the procedure alone is not responsible for final acceptance or rejection of the hearing aid. The major contributing factor is the individualized instruction and instructional material which the student receives as support, in conjunction with, the hearing aid evaluation procedure (Orientation to Hearing Aids course). During and after clinical testing has been completed it is necessary, in order to effect transition into total acceptance of amplification, to provide a habilitative program stressing the didactic, functional, and motivational aspects of amplification and its usage. These considerations are cognitive, psychomotor, and affective in nature. These objectives can be met by following such a program as outlined in this paper.

According to the number of repetitions of post-tests, books 1 and 4 were repeated the most often. This may be due to the extensive didactic and technical material contained within these two books. It is necessary to evaluate each book in terms of its linguistic complexity. This is presently being undertaken. One student required six weeks to complete book 1. Although the student was highly motivated toward using amplification, he was poorly motivated toward such instructional material. It was the opinion of the instructor, after lengthy consultation with the student, that he was more interested in receiving a hearing aid than in understanding its utilization strategies as presented in this course.

In general, the post-test gains were such that long-term retention (over a period of six months) was maintained at about the 83% level for all materials. According to Bigge (1964), "Learning of the most desirable kind produces a rather flat forgetting curve." It can be seen in Figure 1 that retention test scores for the books, with the exception of book 2, remained within eight percentage points of each other. Consequently, long-term retention is maintained.

Previous use was not a factor for final acceptance of amplification. The fact that this finding is not consistent with previous reports, is of little concern. Again, it seems reasonable to account for this in light of the dynamics of the encompassing communication program of the student, especially the design and implementation as presented here.

It was observed that individuals with cut-off frequencies of 4.0 - 8.0 kHz and those with cut-off frequencies of 0.25 to 1 kHz, consistently accepted amplification. The questions of interest are: "Does the fact that no high frequency cues are available influence 'success' of amplification?" and, "Is there a greater tendency for 'tolerance' and 'functional usage' based on the absence of complex tonal-pattern recognition, e.g., fiber decoding)?" There may be vibrotactile cues associated with low frequency amplification that influence successful experiences in amplification selection. Certainly, there is evidence in the literature to suggest that such cues enhance success of amplification (Erber, Note 3). These considerations need to be further investigated.

It is not possible to completely rule out the hearing aid evaluation procedure as an influence in the acceptance or rejection of amplification. However, the course, and subsequently this paper, was designed to discuss how a habilitative program may enhance success of amplification based on current hearing aid evaluation and selection procedures. Much insight has been gained, however, into a new approach to hearing aid evaluation procedures at NTID. Presently, the Department of Audiology is studying the future directions of amplification selection procedures for the severe and profoundly hearing impaired. The principle philosophy, which will underlie all clinical procedures, is that the actual testing will be instructional to the student as well as interpretive for the audiologist.

One of the clinical considerations of this study is the evidence of audio-kinetic nystagmus observed in a small percentage of students. Several questions respective to perception, balance, and cross-modality influences are being addressed as a research project. There is not sufficient information to make a statement regarding its influence on amplification and student functioning. Furthermore, future longitudinal research needs to be done respective to amplification usage once the student has left the educational environment.

The final consideration is the importance of performance with, and utilization of, amplification. The advantages of having the student knowledgeable in caring for a hearing aid while the evaluation is in progress is such that:

1. The loaner hearing aids are better maintained and there are fewer repairs resulting from such loans.
2. The student is positively reinforced by psychomotor skills during the loan period of amplification usage.
3. If problems are encountered, the student has a set of books to which to refer so that mistakes do not become self-reinforcing.

It has been observed that the student is better prepared for the instructional OHA classes. The student has not been arriving at class with the

battery improperly inserted, the telephone switch activated as opposed to the microphone, the plastic tube coupling the earmold and hearing aid twisted, incorrect battery being used in the hearing aid, or other frequent problems associated with new hearing aid users. This serves to enhance their educational and habilitative programs. It is felt that success of amplification is dependent upon:

1. Knowledge of use; and
2. Motivation toward use.

The instructional materials and individualized instruction designed for Orientation to Hearing Aids meet those criteria.

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