

Hearing Aid Evaluation Procedures for Children

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With the passage of Public Law 94-142, we can expect to find substantially more hearing impaired children absorbed into mainstream educational settings. As we all know, this placement will demand much more of the child, the parents and the rest of the hearing health care team than placement in a school for the deaf required. It will also require much more from the amplification system or systems that the child uses. The child who is mainstreamed, almost by definition, requires every possible cue in order to best follow what is happening in the classroom. For this reason the choice of amplification system or systems is essential. The more ideal the amplification system, the more information the child will receive, and, hopefully, the greater the likelihood of successful mainstreaming.

The Purpose of Amplification

When the hearing impaired child relies on the hearing aid for auditory information for the perception of speech, the necessity of appropriate hearing aid selection, and the responsibility of the audiologist is significantly greater than when the child is simply using the hearing aid for environmental clues and for gross speech recognition. Prior to choosing an amplification system, we must consider the purpose of the hearing aid evaluation, and, in fact, the purpose of the hearing aid for that particular child.

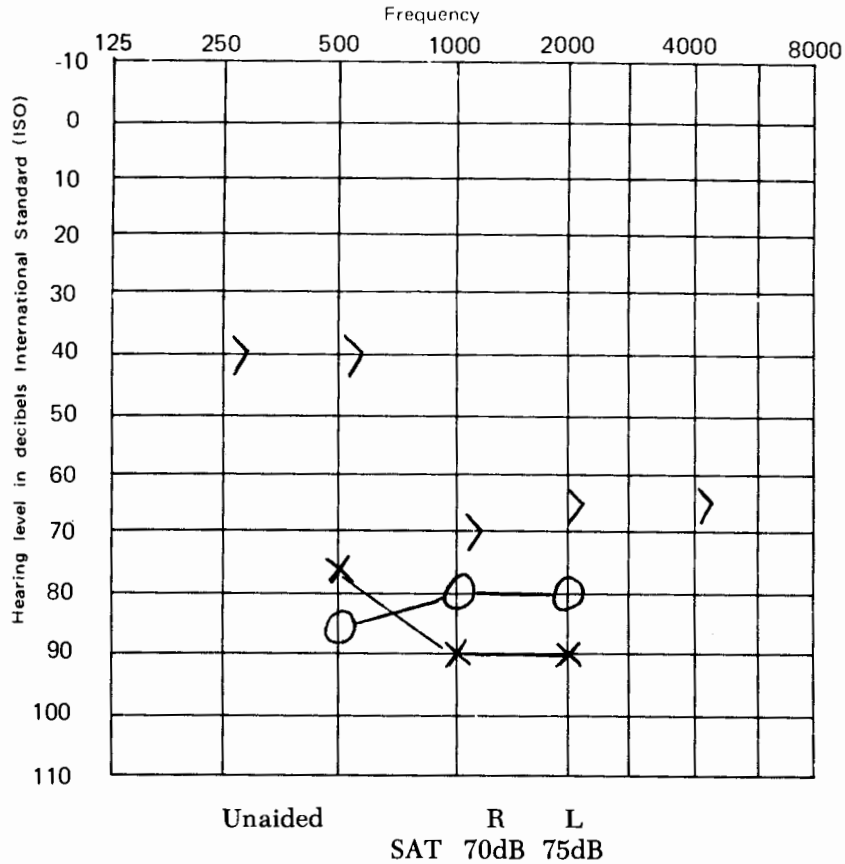
There are several things we must seek and decisions we must make in choosing a child's amplification system. First and foremost, the amplification must enable the child to perceive speech. In order to do this, the hearing aid must provide a good signal to noise ratio. Second, the hearing aid must be simple to operate so the child, parents, hearing therapist or educational audiologist and teacher will be able to use it without difficulty. A hearing aid which is complicated to insert and/or adjust may,

too often, go unworn. Third, the amplification system must allow the child to hear her or himself and to hear others well enough to use auditory information, in the development of speech and language. Fourth, especially for a very young child, the amplification system should be quite flexible. For many children, we may know with reasonable certainty that the child has a hearing loss but it will often be some time before we know the exact dimensions of that hearing loss. We cannot wait until we do know or a great deal of valuable time for auditory input will be lost. By choosing a flexible hearing aid, we allow for the possibility that we can make changes in the amplification the child receives as we are able to determine more about the child's hearing.

Fifth, a determination must be made as to whether monaural amplification, binaural amplification or a system of alternating the hearing aid from right to left ears is best for a particular child. Sixth, a decision as to the type of microphone (front, rear, directional) must be made. Seventh, a decision must be made as to whether ear level or body worn hearing aids will be recommended. Finally, we must determine whether one amplification system is sufficient or whether more than one system is needed. One, for example, for home use, and one for classroom use.

Monaural vs. Binaural Amplification

The trend in more and more clinics is to fit all very young children with two hearing aids (binaurally). This is done based on the experience of many normal hearing audiologists who have demonstrated, to their own satisfaction, the benefits of binaural hearing. However, it is necessary to exercise a bit of caution in deciding whether or not to recommend binaural amplification for a small hearing impaired child. While many, and possibly most children benefit greatly from binaural amplification, there are those who do not. It is very important that the audiologist identify the child who will benefit from binaural amplification and the child for whom monaural amplification will be more beneficial. Katz and Salis, in 1930, demonstrated that there were some hearing impaired people who performed significantly better monaurally, and others who performed significantly better binaurally. At the New York League for the Hard of Hearing, we see many children who resist binaural amplification, and some who, after wearing it for a period of time, refuse to continue to do so. We also have clinical evidence of the kind that Katz and Salis had. Figure 1 shows the hearing aid evaluation results for one child. Test results clearly indicate that this child does significantly better with the hearing aid worn monaurally. His is not an isolated case. Therefore, it would seem to be a good idea to experiment with monaural and binaural amplification before the final hearing aid recommendation is



HEARING AID EVALUATION

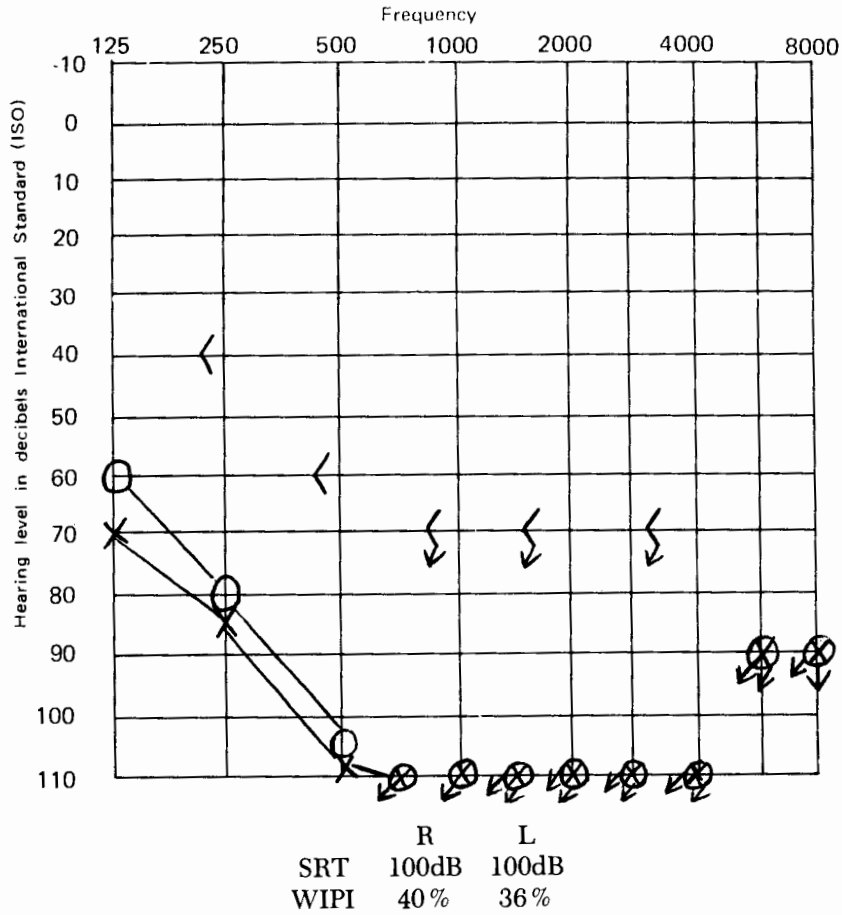
	Aid on Right Ear	Aid on Left Ear	Binaural
250Hz	30dB	50dB	
500Hz	35dB	40dB	
1000Hz	40dB	45dB	
2000Hz	40dB	40dB	
4000Hz	35dB	40dB	
Speech Discrimination (WIPI)	84%	64%	64%

Figure 1. J. L. Age: 3 years. Etiology: Unknown

made. Earmolds may be ordered for each ear. Initially, the child can wear a hearing aid monaurally, alternating between ears on a weekly basis, as well as wearing aids binaurally. Once a child has adjusted to amplification, clinical observation in the test room, in the therapy room, and at home will demonstrate whether monaural or binaural amplification is best for a particular child.

Ear Level vs. Body Worn Hearing Aids

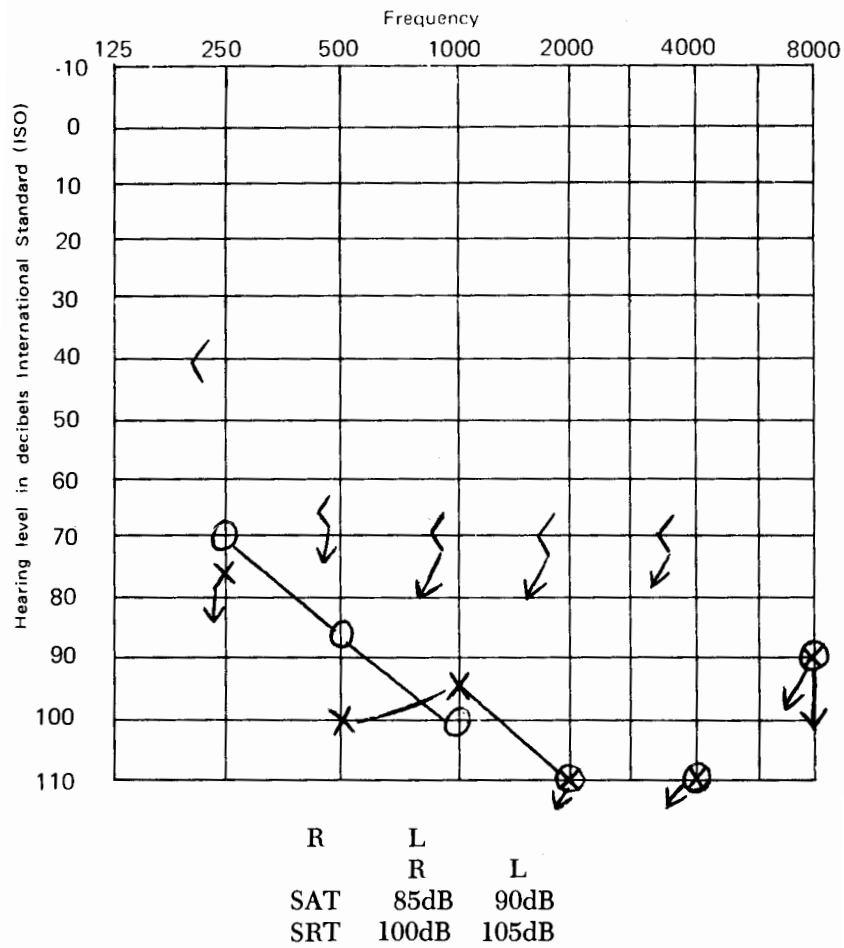
The present trend among audiologists appears to be to fit most hearing impaired children with ear level hearing aids. For many reasons, one would prefer to have a child wear an ear level hearing aid. It is less cumbersome, it attracts less attention, and allows the child to have the benefits of having the microphone at the ear. (In addition, an ear level hearing aid will be more difficult to spill juice into or to fill with sand on the beach.) However, a note of caution is in order. Hearing aid manufacturers would have us believe that the present ear level hearing aids are comparable to body aids in gain, output, frequency response and distortion characteristics. While electroacoustic characteristics may show very little difference, we do find considerable differences in the way some children function with both types of hearing aids. Figure 2 shows the test results of a hearing aid evaluation on a seven year old child. Although pure tone warble thresholds are not significantly different between hearing aids, speech discrimination testing indicates significant improvement with the body hearing aid as compared with the ear level hearing aids. In this case, fifteen different ear level hearing aids or aid settings were tried and none could produce a speech discrimination score comparable to the one obtained with the body aid. The test finding was corroborated by observations by the clinician, the parents, and the classroom teacher. This child functioned much better with a body hearing aid. Figure 3 shows the test results of another child who chose to keep her body aids after extensive hearing aid evaluation. Although testing indicated that she did just as well with the ear level hearing aids as with the body aid, she felt that she had to strain less to understand when she used the body aid. Her classroom teacher verified that she seemed to have less difficulty when she wore the body aid in class. Fortunately, many children do equally well with an ear level hearing aid. However, if what we are seeing with older children who can communicate their listening needs is correct, then we must exercise caution and evaluate both ear level and body worn hearing aids before we make a final hearing aid recommendation.



HEARING AID EVALUATION

	Body Aid	#1	#2	#3
500Hz	50dB	50dB	55dB	60dB
1000Hz	45dB	45dB	50dB	60dB
2000Hz	60dB	65dB	60dB	60dB
3000Hz	75dB	70dB	70dB	70dB
Discrimination at 65dB (WIPI)	40%	24%	24%	30%

Figure 2. D. G. Age: 7 years. Etiology: Unknown



HEARING AID EVALUATION

	Body Aid	Ear Level Aid
250Hz	40dB	45dB
500 Hz	50dB	50dB
1000Hz	55dB	55dB
2000Hz	60dB	55dB
3000Hz	60dB	60dB

Discrimination at
60dB (W-22)

52%

54%

Subjective judgment: Body aid preferred in all situations.

Figure 3. S. G. Age: 13 years. Etiology: Heredity

Maximum Output

There is always a risk of acoustic trauma whenever a hearing aid is worn. Most of us agree that it is a risk worth taking. Without a hearing aid, the hearing impaired child would be able to hear very little and would receive essentially no auditory input, so preventing a 70dB hearing loss from progressing by eliminating exposure to amplified sound does not seem to be a good solution. A certain amount of risk is necessary. Reducing amplification might be a better solution. When choosing a hearing aid, effort should be made to fit the hearing aid that provides the best result at the least possible maximum output. The possibility of evaluating maximum output and comparing it to the acoustic reflex level has been evaluated by some and should be evaluated further. Ideally the output should be less than 120-125dB. Hopefully this will give the child the least possible decrease in hearing and may cause no drop in hearing at all.

Is More Than One Amplification System Needed

Research has indicated that children may demonstrate significantly better speech discrimination when using a classroom auditory training unit. When one considers the possibilities allowable when building a larger unit we can understand why this is so. Mark Ross has demonstrated that speech discrimination may improve by as much as 40% when the child is able to hear the teacher by having the teacher speak directly into the microphone of a classroom amplification unit. This is largely because the signal-to-noise ratio is greatly improved with the microphone only a few inches from the speaker's mouth. However, there can be disadvantages to this system also. In some units, although the children can hear the teacher well, they cannot hear their classmates. If they cannot engage in conversation with their classmates in a natural way, the benefits of the unit should be seriously questioned.

The audiologist must make some decision as to whether one wearable amplification system is sufficient or whether a particular child is in need of more than one system. There are many different types of systems and many factors to consider. Some are merely practical. Does the child attend a school system which already has FM auditory trainers which it expects all hearing impaired children to use? Does the school have classrooms and the auditorium set up with a loop system which requires a telephone coil in the hearing aid? Is there no auditory training system in the school system and no resources available for the purchase of such a system? Other factors are "clinical." Do discrimination tests in noise, and listening experience in the classroom reveal that the child, in fact, does better with his own hearing aid? Is the teacher "uncooperative" and

unwilling to wear the required microphone for an FM unit? Does the family feel that insisting on the school's cooperation in the use of an FM unit might jeopardize the child's ability to remain in the school? Are there psychological factors which would negate the use of this special unit?

Certainly more research is necessary before we can make more definite statements about the efficacy of classroom auditory training units for the hearing impaired child, however, two things remain clear: (1) every child deserves the right to try classroom amplification systems both in testing and in the classroom to determine if greater benefit is received from this type of system, and (2) the audiologist must know what kind of classroom amplification is available in the child's school and, be able to evaluate the child with that unit in order to be able to make the best possible recommendation regarding amplification systems for that child.

Choosing Amplification

It is best if the audiologist has a reasonable estimate of the child's hearing when choosing amplification. Ideally, one should have an audiogram which includes air and bone conduction, and impedance testing for each ear; soundfield warble thresholds, speech awareness, speech reception, and speech discrimination tests for each ear separately and for soundfield. Unfortunately, audiologists are often in the position of having to make hearing aid decisions for young children without all of the above information. Sometimes the child will not accept earphones and the audiologist is unable to obtain responses for each ear separately. Very often, certainly with very young children with severe or profound hearing losses, we are unable to obtain discrimination scores. We are, therefore, forced to make decisions with less than complete information. For that reason the hearing aid evaluation procedure begins rather slowly and we cannot expect to have a satisfactory hearing aid recommendation for a child in one or two sessions. It is important to remember that the better the amplification, the better the chance of the child developing good speech perception. Therefore, we should not be discouraged if the process of choosing the hearing aid takes a long time and we must be willing to spend the time.

Test Procedures

Since the reason for hearing aid use is to improve speech perception, we must be very careful when evaluating the hearing aid to use measures that tap this. The soundfield aided warble tone audiogram provides valuable information, but in itself, it is not sufficient. We must evaluate the child's ability to perceive speech. Speech testing is too often ignored in

evaluation procedures with severely hearing impaired children. Audiologists fall into the trap of assuming that because a child is severely hearing impaired, the child will not be able to perceive speech. In reviewing evaluations from centers, we often find that while an effort may be made to obtain a speech awareness threshold, no attempt has been made to obtain a speech reception threshold or a speech discrimination score. We must test speech discrimination in order to determine how well a child is functioning and what areas of auditory perception require further auditory training. Further, if we do not measure speech perception when evaluating hearing aids, we cannot know if the hearing aid we choose is sufficient for assisting the child in developing speech perception. It would do us well to remember that our level of expectation for children strongly influences their development.

Speech Audiometry

Our goal for speech discrimination testing should be to have the child tested on a standard speech discrimination test, such as the CID W-22 lists. This is often not possible at the initial hearing aid evaluation procedures with very young severely hearing impaired children. However, there are still some speech audiometric procedures that can be used. First, a speech awareness threshold should be obtained for every child being evaluated. For many children, speech reception thresholds are possible even at the initial hearing evaluation. If the standard speech reception task is not possible, it may be possible to test using spondee pictures or selected objects. If it is not possible to test using standard stimuli, discuss with the parent or clinician what words the child perceives auditorially (without the use of visual clues). It may be possible to obtain a speech threshold using other words the child knows, such as body parts, numbers, colors or familiar objects. If a speech threshold is obtained, a speech discrimination test should be attempted. While the CID W-22 may be the preferred test, it may be a long time before the child can perform using this test. There are, however, other valuable tests that can be used: the CID-PBK (phonetically balanced kindergarten) lists and the WIPI Test (Word Intelligibility by Picture Identification) by Ross and Lehrman, are both valuable for children. The WIPI Test is a closed set task making the discrimination procedure easier for the child. Additionally, since the child points to the chosen answer, poor speech need not interfere with the test procedure. The PBK lists use standard procedure requiring an oral response but use a vocabulary more likely to be familiar to a young child.

One of the responsibilities of the audiologist is to "monitor" a child's ability to function auditorially. Therefore, one should fully expect to be

able to at least try to obtain speech discrimination testing on the children one evaluates. I expected that by the time a child with a severe (70dB) hearing loss is in the third grade, the child should obtain a speech discrimination score of 70% using the CID W-22 tests when wearing a hearing aid. A child with a profound (95-100dB) hearing loss should obtain an aided score of 20-40% on the CID W-22's by the third grade. If the child does not, it would seem to indicate that the child is not making the best use of his/her residual hearing and further auditory training is needed.

The need for speech testing in hearing aid evaluations is shown in the test results in Figure 4. While soundfield pure tone warble thresholds did not indicate a significant difference between hearing aids, in this case, speech audiometry did. Had a hearing aid recommendation been made on the basis of the pure tone and speech reception thresholds alone, the child might have been denied the benefit of a better hearing aid. This, again, is not an isolated case.

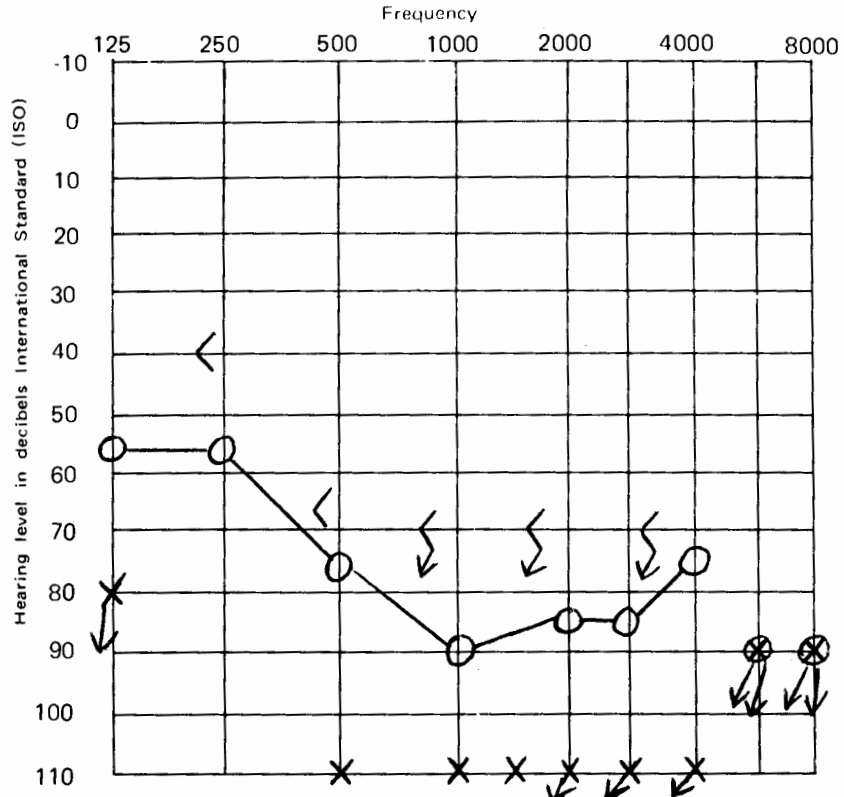
Adjustment to Amplification

A period of adjustment is required when a child first receives a hearing aid before optimal results are obtained. It is most difficult to attempt to do a hearing aid evaluation on a child with a severe or profound hearing loss at the time that the child first begins to use amplification. To optimize the evaluation procedures, the child should be well adjusted to amplification at the time of the evaluation and should be responding to sound, and hopefully to speech, consistently. The amount of time it takes to adjust to amplification will vary. For a child with a mild hearing loss, it may only take a few weeks. For a child who has a moderate hearing loss, it may take two to three months to adjust to amplification. It may take six to eight months for a child with a profound hearing loss.

The fact that a final decision about a hearing aid has not been made does not mean that the child is without amplification. During the adjustment period, the child should be using a "loaner" hearing aid. During this time period the parents, the clinician and the audiologist can observe the child's responses to amplification and make changes in the loaner aid appropriately. After the child has adjusted to amplification and responds consistently, the hearing aid evaluation procedures can begin in earnest and should only take a few sessions.

The Final Hearing Aid Recommendation

After the hearing aid evaluation, which may take several sessions, the audiologist should have decided on one or two hearing aids with which the child seems to function very well. At this point, we suggest that the



R L
 SRT 65dB 100dB
 WIPI 86% 0%

HEARING AID EVALUATION

	#1	#2	#3	#4
500Hz	30dB	25dB	30dB	30dB
1000Hz	25dB	20dB	45dB	35dB
2000Hz	35dB	40dB	45dB	40dB
3000Hz	40dB	45dB	40dB	45dB
Discrimination at 60dB (WIPI)	68%	68%	88%	80%

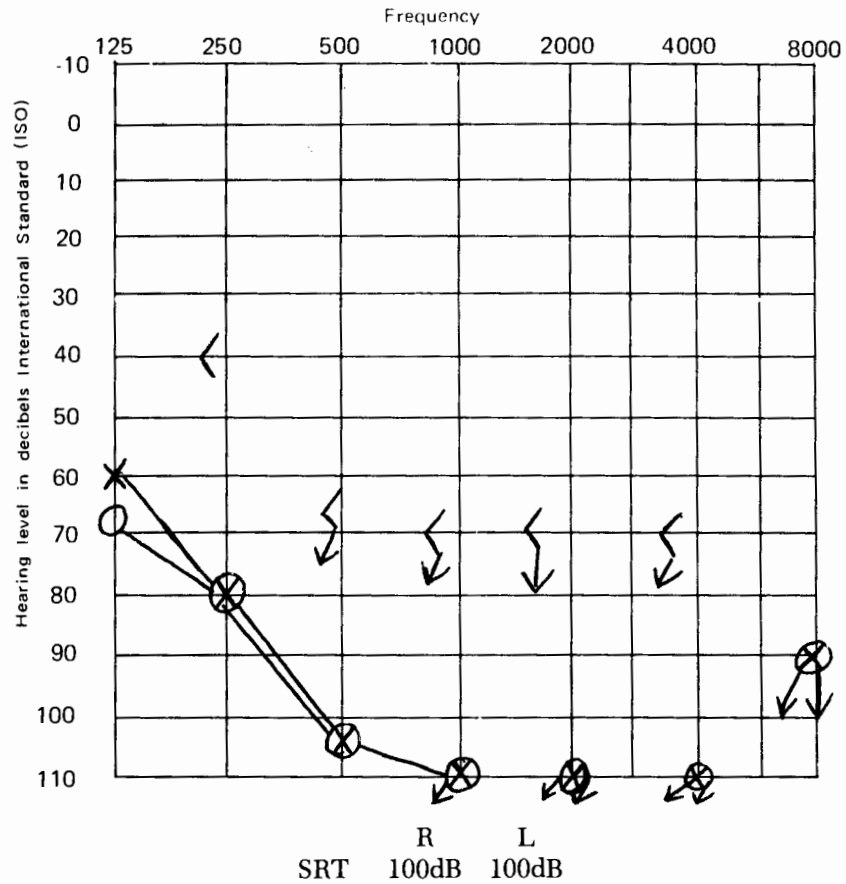
Figure 4. L. S. Age: 6 years. Etiology: Unknown

child use the recommended hearing aid for a few weeks. During this time, the parents, the clinician, and the audiologist can observe the child's functioning with the hearing aid. With infants, one should observe the distance at which the infant responds, the ability to imitate, the response to commands, and the amount of vocalization. With children who are a little older and who have more speech discrimination, one should observe the child's ability to discriminate in group situations, the distance at which the child can discriminate, the child's ability to discriminate in the classroom, as well as the child's ability to monitor her or his own speech. The final trial period immediately prior to purchase allows the audiologist, the hearing clinician, and the parents the opportunity to make certain that the child is functioning as optimally as possible with the recommended hearing aid so as to be assured that the aid that is purchased will be satisfactory.

Experimenting with Hearing Aids

Audiologists at the New York League for the Hard of Hearing have been experimenting with some hearing aid modifications in an attempt to allow more children to function better with ear level hearing aids. Several years ago a hearing aid manufacturer released a new ear level hearing aid which used an external, body aid type of receiver, instead of an internal one. It seemed to us that this might produce better responses on some of our children. However, for many children the aid was not powerful enough. We asked two major hearing aid manufacturers to modify their most powerful ear level hearing aids to enable us to use an external receiver. They have done so and the results have been astounding. Figures 5 and 6 show hearing aid evaluation results with aids so modified. In Figure 5, one can see the dramatic improvement in speech discrimination when the aid with the external receiver is used. For the child whose evaluation is shown in Figure 6, the test results are not startling, but the clinical observation is. When using the hearing aid with the internal receiver, this child relied a great deal on lipreading, and almost exclusively on audition when the external receiver was used. It is interesting to note that the manufacturer of the hearing aid is able to find only one testable difference between the hearing aids with the internal and external receiver; the aid with the external receiver has a slight decrease in amplification between 3000 and 4000Hz. There is clearly some "unmeasurable" difference that is causing us to record these drastic speech discrimination improvements.

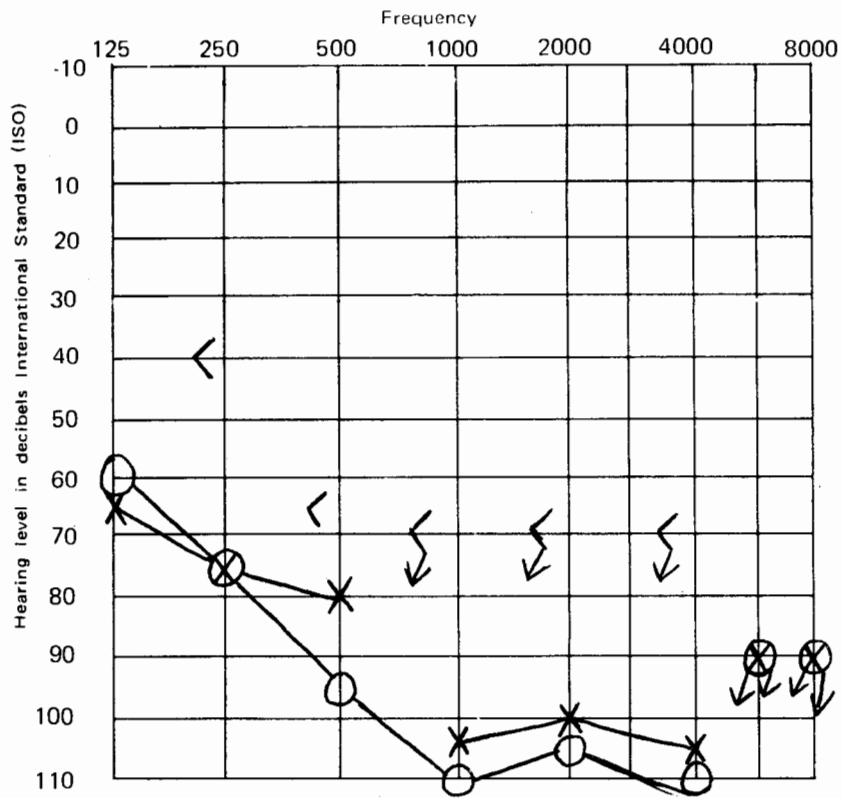
We have also been experimenting with tactile stimulation as an aid to children who have very little or no measurable hearing. These children receive very little benefit from standard amplification. We may not be



HEARING AID EVALUATION

	Aid with Internal Receiver	Aid With External Receiver
250Hz	50dB	45dB
500Hz	65dB	55dB
1000Hz	55dB	50dB
2000Hz	85dB	65dB
3000Hz	No Response	No Response
SRT	50dB	40dB
WIPI	44 %	56 %

Figure 5. D. E. Age: 8 years. Etiology: Unknown



	R	L
SRT	90dB	80dB
WIPI	66%	72%

HEARING AID EVALUATION

Aid with Internal Receiver	Aid with External Receiver
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WIPI	72%	76%
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Figure 6. E. R. Age: 11 years. Etiology: Rubella

providing, with even the most powerful hearing aid, enough stimulation to assist this population. For these children, we have been using binaural amplification with one aid using an air conduction receiver and one using a bone conduction receiver. The bone conduction receiver, held to the wrist with a wrist band, seems to give some of these children the small amount of vibratory stimulation that enables them to respond. Some of them use it for only a little while and then use standard, air conduction stimulation only, others continue to rely on the vibrotactile stimulation.

Conclusion

There is much that needs to be known about hearing aid evaluation procedures with children. What we know for sure is that the answers are not simple ones. Each child requires extensive evaluation and "experimentation," so that he or she hears and therefore develops as best he or she can. The process is long, and often tiresome, but the end result is worth the effort.