THE HEARING-IMPAIRED CHILD
IN AN OPEN CLASSROOM

An Honors Thesis (ID 499)

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Introduction

There is a widespread opinion that a hearing aid is the "magic cure" for the child with a hearing loss. It is assumed that the hearing aid can remedy all of the child's disabilities and that he will suddenly be able to function at a normal level. While it is true that the hearing aid is a great asset to the hearing-impaired child, it alone cannot be expected to result in complete "recovery". One cannot assume that the mere fact that the child has been fitted with a hearing aid assures that the aid is functioning at maximum efficiency for that child. Sometimes the aid that the child has been wearing may be completely unsatisfactory for him.

A recent development in amplification methods which has proved to be a great asset is the induction loop amplification system (ILA). The ILA consists of a current which is fed from an amplifier through a loop of electromagnetic wire. A magnetic field is created in the area within the loop. Changes in the electromagnetic field are picked up by a coil (telephone pickup or telecoil setting) on a regular hearing aid. From there the current is fed into the amplifier of the aid and in the usual way it is transmitted through the receiver of the aid to the ear (Watson, 1967, p. 96).
Since the teacher wears a microphone, usually a collar or harness, the signal is stronger than the background noise because of the proximity of the microphone. This results in a better signal-to-noise ratio (S/N ratio), which is crucial to the hearing-impaired child.

Any environmental noise which interferes with the speech signal that the child receives reduces the S/N ratio. When the hearing-impaired child is in the classroom, the noise levels may become so high as to impede the strength of the signal. The ambient noise level must be reduced to provide a suitable environment for learning.

Statement of the Problem
The purpose of this study was to investigate the effectiveness of open classroom situations in the education of hearing-impaired children in an elementary school. This was accomplished by comparing the ambient noise levels in the room to the requirements for effective education of these children. The merits, characteristics and uses of amplification is also evaluated.

Review of Literature
In preparing for this study, several topics were reviewed. These involved 1) effectiveness of hearing aids for classroom use 2) discrimination abilities in noise for normals and hearing-impaired individuals and 3) effectiveness of
induction loop amplification systems.

Effectiveness of Hearing Aids for Classroom Use

As stated earlier, often the hearing aid that the child is using is totally unsuitable to the individual needs. The child cannot function and learn to his fullest capabilities if he cannot hear and discriminate well. Even if the aid is suited to the child it must be in good working order to be effective.

Zink (1972) found that a significant number of aids are functioning inefficiently. During a two-year study of hearing aids being used in classes for hearing-impaired children, he found that of 92 aids, 45% were totally unacceptable. Of those that were unacceptable, 24 (59%) were characterized by excessive distortion, 14 (44%) failed to meet frequency response requirements, 10 (24%) had improper acoustic gain, and 10 (24%) had physical imperfections such as defective cords, receivers or gain controls. Some were completely inoperative.

In a study comparing discrimination scores in varied conditions, Ross and Giolles (1971) indicated that the use of hearing aids in an ordinary classroom resulted in very poor discrimination scores for the majority of the hearing-impaired children, and a number of children scored zero or near zero on discrimination tasks. These results were obtained through the use of both binaural and mon-
aural aids and both body aids and ear-level aids.

These findings strongly suggest that a significant percentage of the hearing aids being worn by hearing-impaired children are functioning inefficiently. (Zink, 1972). It appears that regardless of the type of aid used, the results were the same. The child simply does not get the amount and quality of amplification to fill his needs.

**Discrimination Abilities in Noise**

The S/N ratio is a very important aspect of the problem. Young and Harbert (1970) found that the optimal speech discrimination scores on a test in which speech and noise were mixed and presented monaurally were obtained at a ratio of approximately +15 dB. However, when the noise was presented to the "bad" ear and the signal was presented to the "good" ear, 5 dB less S/N ratio was required for speech discrimination equivalent to normals. They also found that when both the signal and the noise were presented to the deafened ear, the result was a need for 10 dB more S/N ratio.

Dale (1962), as reported by Ross and Giolles (1971), found that under poor listening conditions discrimination scores decreased from 54% at four feet from the speaker to 39.2% at 22 feet from the speaker. Under good listening conditions he found discrimination scores of 64% when the listener was 22 feet from the speaker.
Watson (1964) conducted a study in which speech discrimination tests were recorded at three feet from the microphone in a sound-treated room and again in a normal classroom at nine feet from the microphone. When these tests were played to 19 hearing-impaired children, it was discovered that the average discrimination score of 84.8% for the good recording situation fell to 35.2% in the poor recording situation. Normal hearing adults also listened to the tape and received discrimination scores of 98.6% in the good condition and 43.3% in the poor condition. Partially hearing adults received scores of 91.8% discrimination for the good listening condition and only 28.3% during the poor listening condition. These findings accentuate the fact that the same conditions of noise are much more harmful to the discrimination of the hearing-impaired.

Kuyper (1972) found that the "cocktail party effect" (CPE) is in effect in situations of competing noise. CPE is a phenomenon in which the listener has better discriminatory skills in an environment of noise when he can use two ears rather than only one ear. This is apparently due to the tendency of the brain to subtract the signal coming in one ear from the signal entering the other ear (Harbert and Young, 1970).

Carhart and Olsen (1970) conducted a study in discrimination which involved four groups (each with twelve
subjects). Their groups were 1) normal hearers 2) conductive losses 3) nonpresbycusics sensorineurals and 4) presbycusics. The study involved one binaural and two monaural presentations. They found that during unaided listening, the responses of conductives were quite close to normal abilities. During aided listening tasks, both normals and conductives were adversely affected by ambient noise, but conductives were much more affected by noise than normals. The undesirable amplification features of the hearing aid produced added masking during aided listening, and the conductives seemed to be less able to overcome this masking. Presbycusics and sensorineurals were both much more disturbed by ambient noise during aided listening. (Carhart, Tillman and Olsen, 1970).

In a study conducted by Hirst (1971), results were obtained which indicated that both normal listeners and hearing aid users are better able to understand speech presented concurrent with noise or competing speech under the following conditions:

1- if speech and ambient noise come from spatially separated sources
2- if the listener is able to localize readily.

Further results indicated that the listener will be better able to localize when he uses two spatially separated aids (or ears for normals).
Effectiveness of Induction Loop Amplification Systems

Fisher (1964), as reported by Ross and Giolas (1971), found that discrimination scores for partially hearing children at a distance of 15 feet decreased from an average of 87% when using the induction loop system to 51% while using their own hearing aids without the loop. The closer the child was to the source while using their own hearing aid, the higher the intelligibility scores.

Sung, Sung and Hodgson (1973) report in their study the work of Calvert and others (1965) in which it was found that the acoustic gain of the hearing aid was somewhat greater below 500 Hz when used on the telecoil setting than when it is used on the microphone setting.

Sung, Sung and Hodgson (1973) found that with a properly functioning loop, a hearing aid operating on its telecoil setting will provide better low frequency response than the microphone setting alone. Tillman, Carhart and Olsen (1970) report that even for normal hearers, speech in the presence of ambient background noise was masked as much as 12 dB more when reproduced by a regular hearing aid than when a loop system in good working order was used.
Method
A sound level meter was used to measure the sound levels of three class areas in an open room type situation at Grissom Elementary School in Muncie, Indiana. Each class area contained three sections in which the children attended their classes. Noise levels were obtained under three conditions 1) empty classroom 2) with children present but without the teacher's speech and 3) with children present with the teacher's speech. The same location was used for each measurement, that being a location in each section or area which was approximately ten feet from the class. (See Table 1).

Results
The children in these classrooms had hearing abilities which ranged from moderate to profound losses. A child with a profound loss was in the second grade area and in the fourth grade area was a child with a severe loss. The fifth grade area had three children, a moderate, a severe and a profound loss. For sound level measurement results, see Table 2.

Discussion and Implications
The amount of noise present in an environment is a very important factor which must be controlled in order to ensure maximum benefit from the instruction the child will receive. Interfering (ambient) noise from many sources
The location of the sound level meter is indicated by X.
Table 2: Sound level measurements dB SPL under 3 conditions: 1) empty classroom 2) without the teacher's speech 3) with the teacher's speech.

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<th>Condition</th>
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<td>All classes 50 dB or below empty</td>
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Learning Area

Grades 1, 2, 3
often plays an important detrimental role in the education of the child. Noise which seems normal and of little consequence to the normal hearer can become a seemingly insurmountable obstacle to the hearing-impaired child. A normal classroom occurrence such as writing on the blackboard generates approximately 45 dB of noise at nine feet from the board (Sanders, 1971, p. 209). The intensity of the teacher's voice may be only 10 dB higher than the chalkboard noise resulting in a very poor S/N ratio. This would have a very detrimental effect on the child's discriminatory abilities.

As noted in the results of the current study, an even poorer S/N ratio than this was found in this situation. In only two instances did the teacher's speech exceed the ambient noise by even 10 dB. This seems to indicate that the noise levels in these rooms are simply too high to provide a proper opportunity for the children to hear the teacher's voice, especially if the child happens to have a hearing impairment. With the original impairment of hearing and the consequential loss of information, the added burden of such excessive noise makes good comprehension virtually impossible.

Palmer (1961) reports that conversational speech, from a distance of 10 to 15 feet, is heard at a level of approximately 60 dB. This is an average level since
some sounds are softer than others and we emphasize some words or syllables. The results of the current study show that the noise levels in these rooms are too high to allow the child to hear the teacher if she speaks in a normal voice. The needed contrast between the noise and the speech is just not present. The normal hearing child would have trouble understanding, but the hearing-impaired child has no chance at all.

Hearing aid users suffer a much greater auditory disturbance from competing sounds than a normal hearing person does. When one considers the person's unaided discrimination abilities in ambient noise, it will be found that his aided discrimination scores are not as good as would be expected (Tillman, Carhart and Olsen, 1970).

The hearing aid is non-selective in its amplification. It will amplify the teacher's speech but it will also amplify the noise. Since a great deal of this environmental noise extends into the speech frequencies, amplification will often result in a masking of speech. Environmental noise is concentrated in the low frequencies (Sanders, 1971, p.209). The hearing-impaired child will be more likely to have residual hearing in these low frequencies. This compounds the problem. The hearing-impaired child needs to get the maximum amount of infor-
motion he can get. He needs to be able to make the most use of his residual hearing and his localization skills to find the source of the speech so he can pick up visual cues concerning the message. When his residual hearing is masked by ambient noise which equals or perhaps exceeds the energy of the speech signal, he will find it very difficult to localize. Redundancy in the form of visual and auditory cues are vital to the hearing-impaired child.

In order to benefit from the best auditory signal, the child must receive the message in the clearest and least obscured manner possible. It is obvious from the results of this study, as well as previous studies, that the children simply are not getting the needed amplification in the classroom under existing conditions.

The child can, however, be helped in his problem by being provided with a better S/N ratio. In order for all the damaging effects of noise to be reduced, the hearing aid user must receive the best possible S/N ratio. One way to ensure that the child receives the most favorable S/N ratio possible is to move the speaker closer to the microphone of the hearing aid. As the distance between the speaker and the hearing aid receiver are decreased, intelligibility scores are increased (Ross and Giolas, 1971). It is, however, not always possible to do this.
An induction loop amplification system (discussed earlier in the paper) could be used to decrease the distance between the microphone and the receiver in just such a way. There are three main types of loops, grid, cloverleaf, and room perimeter (Matkin and Olsen, 1970b).

When the ILA system is being used, the child does receive a much better S/N ratio because the microphone is right at the teacher's mouth. Therefore, the microphone picks up the teacher's speech louder than the background noise. He then receives a better S/N ratio which results in better discrimination and should lead to better school work.

There are other advantages to using an ILA system. Among these advantageous features are the ability of the child to move freely around the room without the restriction of cords and headsets, and the child has the benefit of using the same instrument in all situations and having the aid with him at all times due to the fact that the regular hearing aid is used (Sung, Sung and Hodgson, 1973). The user of an ILA system can also enjoy the benefits of a more suitable frequency response, with better amplification of important frequencies, and a more accurately reproduced sound quality (Palmer, 1961).

When the regular hearing aid is used without the benefit of the loop, the child may be several feet from the teac-
her at various times during the day. This provides a better opportunity for background noise to overshadow the message. Northcott (1971) found that an ideal distance for the child to be from the teacher is eighteen inches. This provides the best opportunity for the child to pick up any visual cues and results in a good S/N ratio if the classroom is relatively quiet. Three feet is the absolute maximum distance the unaided child should be from the teacher. It is extremely difficult to conduct a class while remaining no farther than three feet from a particular child. If the ILA were being used in conjunction with the regular hearing aid this would not be a problem since the signal is uniform from any location within the magnetic field (Berg and Fletcher, 1970).

One factor which must be remembered when considering the effectiveness of the ILA is that it is only as effective as the instruments with which it is used. The frequency characteristics and gain of the ILA are the same as the hearing aid used. This is why it is so very important to match the characteristics of the aid to individual needs. Along these same lines, the S/N obtained with an ILA can be harmed by noise from adjacent ILA systems and from the amplification system or the aid itself.
The performance of an ILA is usually measured and evaluated in a laboratory setting. Many times the system will not react the same in a laboratory as it does in the school. For this reason, there should be a thorough evaluation of any ILA system after it has been installed in the classroom (Matkin and Olsen, 1970b).

One may think that from the emphasis placed on noise and its harmful effects to a hearing-impaired child that the integrated classroom is a bad situation. This is not true. There are many advantages to an integrated classroom. Being in the classroom with hearing children gives the hearing-impaired child an excellent opportunity for social interaction. The child is exposed to the "normal" world of the hearing child by being in classes with them. They have a chance to copy appropriate behavior by seeing other children, they are able to get rid of some of the stigma of being different or "strange" by allowing hearing children to get to know them (this leads to more acceptance of the child and thus further socialization). The hearing-impaired child is more challenged and stimulated toward further inquiry by being in a hearing group. They are encouraged to think and communicate in terms of words. When hearing-impaired children are grouped together they reinforce each other's silence (Northcott, 1971b).
A related question is whether the open classroom is beneficial or appropriate for the hearing-impaired child. There is much debate on this subject and inconclusive evidence leaves the question to personal preference. The open classroom is a well equipped space which usually occupies the area of three classrooms and employs the skills, knowledge and attention of three or four teachers. In this respect there is a great advantage because each teacher can stress his strong points and minimize his weaknesses. There is also the advantage of more opportunity for individual or small group instruction and attention.

The darker side of the question emphasizes the noise levels found in the room which, as I have shown, tend to rise to high levels. The rooms must have very good acoustical properties and absorbent material to avoid disastrous echo and reverberation (Katz and Matkin, 1974).

One cannot assume by looking at the hearing impairment that a child will function in a certain way. We can say with certainty that a particular condition will make the situation more difficult but many factors enter into the overall abilities of the child. The actual impairment to functioning is a combination of factors including sensitivity loss (the actual hearing loss), age of onset and cause, supportiveness of the child's environ-
ment, discrimination abilities and intellectual capacity (Katz and Matkin, 1974). Children with very definite and seemingly devastating hearing losses are being placed in regular classrooms and are functioning adequately (Northcott, 1971; Matkin and Olsen, 1970).

Rister (1975) conducted a study in which she compared hearing-impaired children in special classrooms to those in regular classrooms. The group in the regular classroom consisted of 26 boys and 29 girls, and the special classroom group consisted of 19 boys and 14 girls. She found that of the 33 in the special classroom group, 54% were not achieving adequately for their age and grade level but 81.9% of the regular classroom group were achieving adequately for their age and grade level. Adequacy of achievement was measured by determining whether they were enrolled and functioning at a level within one year of their grade expectancy for their chronological age.

Obviously, from these results it is safe to assume that the hearing-impaired child can function successfully in an integrated setting. Hearing-impaired and deaf children no longer have to be different (Conner, 1972). Sometimes the mere act of labeling the child deaf is paramount to labeling them hopeless. Hard-of-hearing children could conceivably become "deaf" adults simply because
they were labeled as "deaf" and, therefore, their educational potential was slighted or underestimated (Berg and Fletcher, 1970).

Suggestions for Further Study
Are the advantages of the integrated open classroom sufficient to warrant the inclusion of the hearing-impaired child into the program? This question must be answered by the individual administrator after careful consideration of the advantages and disadvantages of the situation.

Further study is warranted in the area of the effectiveness of the open classroom for the hearing-impaired child. Information regarding the scholastic records and achievement of the pupils involved would provide valuable information about the problem. Careful comparisons of knowledge as indicated by classroom activity and achievement would give an indication of the child's comprehension of his lessons and the ability to use information gained through such a situation.

The social and emotional aspects of the integrated open classroom should be taken into consideration for further study. Do these children become more socially accepted through their exposure to hearing children? Are the children better equipped to function in a hearing world after the experience?
Finally, we must consider whether the situation makes too many demands upon the child by asking him to compete against noise to keep up with the other children who are not so drastically affected by it.
BIBLIOGRAPHY


