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Optical environment in classrooms for hearing-impaired children: recent developments and continuing needs

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INDEPENDENT STUDY: REVIEW OF THE LITERATURE

OPTICAL ENVIRONMENT IN CLASSROOMS FOR HEARING-IMPAIRED CHILDREN

RECENT DEVELOPMENTS AND CONTINUING NEEDS

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Introduction

In general, special schools for the deaf provide instruction to two main groups of hearing-impaired children: the "severely hearing-impaired" and the "profoundly" deaf. Those in the first category have average hearing-threshold levels for 500-1000-2000 HZ between 70-95 dB (ANSI, 1969), while those falling into the second category have average thresholds poorer than 95 dB. For the purposes of this paper, however, it is more important to distinguish these two groups on the basis of their ability to understand speech rather than their ability to detect pure tones.

Recent research has demonstrated that the acoustic speech-perception capabilities of severely hearing-impaired children are quite different from those of profoundly deaf children. For example, it has been shown that severely hearing-impaired children can discriminate low frequency cues almost as well as can people with normal hearing (Pickett and Martin, 1968; Pickett and Martony, 1970), can distinguish voicing and nasality in a set of plosive and nasal consonants (Erber, 1972b), and can understand spondees with a high degree of accuracy (Erber, 1974b). In contrast, profoundly deaf children have difficulty distinguishing voicing and nasality in plosive and nasal consonants (Erber, 1972b) and cannot recognize common spondaic words (Erber, 1974b). They seem to perceive little more than gross time and intensity patterns in acoustic speech signals (Erber, 1972a). In fact, there are those who suggest that they do not hear at all, but instead detect amplified acoustic stimuli using vibrotactile receptors in their ears (Nober, 1970; Erber, 1979). These two capacities for the perception of amplified speech, (1) auditory spectral discrimination on the basis of low-frequency cues and (2) vibratory pattern-perception alone, provide very different kinds of additional information to a child depending on lipreading for oral communication.

It appears that severely hearing-impaired children achieve high levels of oral communication skill so rapidly because they are able to receive place-of-articulation speech information via lipreading <u>and</u> complementary voicing, manner-of-articulation, and formant information through low-frequency hearing. On the other hand, communication generally is more difficult for profoundly deaf children because, although they too receive place-of-articulation speech information through lipreading, amplification merely provides supplementary information to them in the form of time and intensity patterns (Erber, 1972a; Erber, 1974b). The important distinction is whether the child receives acoustic information through a hearing aid that complements or just supplements the cues that are available to him through lipreading (Erber, 1974a). However, both the severely hearing-impaired child and the profoundly deaf child depend on vision to varying extents for communication and language learning. A poor optical environment, therefore, can be detrimental to their educational development. The hearing-impaired child's ability to perceive speech audio-visually is an important aspect of his or her everyday communication needs (Erber and Thornton, 1979).

A major component of the optical environment is the illumination factors in the design of classrooms for these children. Not much research has been conducted in this area, but this paper will attempt to review what has been done and make recommendations for future research.

Review of the Literature

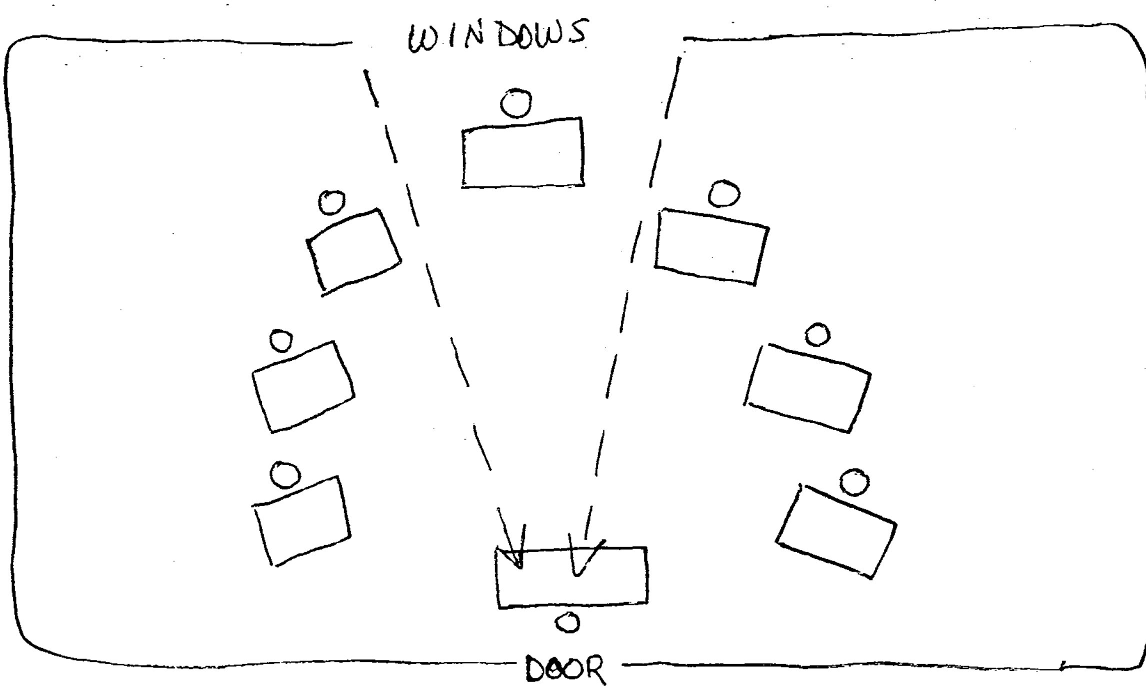
Erber (1971) described some of the effects of distance on the visual reception of words and individual phonemes without supplementary acoustic cues. His results showed that with direct illumination of the mouth and surrounding facial area, the smaller the distance that separates the talker and the observer, the higher is the intelligibility. Therefore, under similar conditions, a minimal separation between a teacher and a deaf child is indicated for maximum communication effectiveness. However, before these results could be applied to the design of facilities at schools for the deaf, further studies were required to examine the effects and interactions of many other variables, for example: (1) illumination level, (2) ratio of facial to background illumination, (3) angle of incident light, (4) distance between talker and observer, (5) horizontal angle between talker and observer, and (6) vertical angle between talker and observer.

Such studies were eventually undertaken. Erber (1974a) investigated the effects of angle, distance and illumination on visual reception of speech using profoundly deaf children as subjects. He found that regardless of the illumination conditions, deaf children achieved their best visual word-recognition performance when they observed a speaker from within the horizontal range of 0 -45°. When this horizontal angle of observation was increased to 90°, lipreading scores decreased about 14 - 22%. In general, for horizontal viewing angles within the range of 0 - 45°, the smaller the distance between the speaker and the lipreader, the greater was the visual intelligibility. With mouth-level illumination of the speaker, minor variations in the vertical viewing angle (from -30 to +30°) had little effect on lipreading performance.

With a 0 to 45° horizontal observation angle, illumination conditions which shadowed the interior of the mouth (for example, overhead lighting) lowered lipreading performance about 3 - 12% below that which was obtained for 0 or +45° angles of incidence. With frontal illumination provided, a wide variation in facial luminance had only a small effect on visual intelligibility. However, the ratio between facial and background brightness can be important; when low facial luminance is accompanied by high background luminance, communication through lipreading proved to be extremely difficult.

In many classrooms at schools for the deaf, the pupils' desks are arranged in a semicircle around the teacher. This desk arrangement requires several children to lipread the teacher from an extreme horizontal angle, that is, greater than 45°, regardless of the direction in which the teacher faces. In addition, the sources of light in most classrooms are windows (sunlight) at the side of the room and fluorescent or incandescent fixtures mounted on the ceiling. These lighting conditions generally shadow the interior of the teacher's mouth and obscure many postdental tongue articulations. This combination of factors can make it very difficult for a child to learn speech and language from an adult model.

Erber offers an alternative to this arrangement. The teacher faces the windows, which provide similar oral and facial illumination, and the desk pattern is compressed so that all children observe the teacher from favorable positions and smaller distances compensate for more extreme angles like so:



There is a major drawback to this arrangement however; some pupils occasionally may find it difficult to observe one another. Other suggestions that Erber considers are (1) the use of special lighting or reflective surfaces at the level of the teacher's mouth, (2) the provision or a swivel chair for each child, and (3) the separation of classes into small groups for conversational purposes.

In this study, Erber did not determine what extremes in <u>vertical</u> viewing angle cause significant decrements in visual intelligibility and what sort of interaction exists between the vertical viewing angle and the angle of incident light. Reflectance of the surface <u>behind</u> the teacher did not seem to be a major factor when dealing with classroom illumination, although he concludes that arrangement of materials in this area may be important in order to minimize distracting influence in the classroom.

These findings help describe a range of environmental conditions under which satisfactory visual communication through lipreading can take place. The next step was to attempt to specify criteria for the design of classrooms with environments optimal for lipreading and then implement these ideas. Most commonly accepted methods for assessing and providing illumination in classrooms are based on the assumption that reading and desk work are the most important visual tasks (Illumination Engineering Society, 1972). Rarely considered is the classroom for the hearing-impaired child in which visual communication through lipreading is required. Erber (1979) reports that improving lighting in a classroom for deaf children requires an approach that entails more than just installing more overhead light fixtures. It has been determined that the amount of light projected into the teacher's mouth should be very similar to the amount of light on her face for optimal visual communication through lipreading (Erber, 1974a). Given the need for maximum visibility of post-dental tongue articulation, the overall level of light in the room seems to be of secondary importance.

To achieve similar oral and facial brightness, the teacher should look toward the major source of classroom light while speaking to her hearing-impaired pupils. For this reason, it has been suggested that she face the windows while speaking. However, in some rooms, natural light from windows is not available or is reduced considerably by obstructions and artificial interior lighting must be used to compensate. In other classrooms, certain conditions (e.g., location of blackboards) make it difficult for the teacher to face the windows while speaking. Usually, conventional overhead lighting is employed to combat these problems, yet it is not completely desirable because it produces shadows in the mouth which can visually obscure the production of post-dental consonants (Erber, 1974). Erber (1979) decided to begin a general experimental program to determine how to optimize lighting in three classrooms with such typical illumination problems as insufficient natural light from windows, surface glare off desk tops and blackboards and poor oral/facial illumination levels. Light measurements and teacher/student judgments guided design strategies. Modifications included reorientation of desks and installation of special screens and louvers to minimize glare from sunlight. Erber also found that by mounting flourescent lights on a back wall one could improve classroom illumination in problem cases, producing good oral/facial levels of brightness (e.g. about 7 - 10 fl) under which post-dental articulations were visible. Teachers were comfortable in this light environment and they did not report any annoying side effect such as after images, eyestrain or headaches. Although the wall fixtures alone provided good oral and facial light levels, it was also found that by retaining overhead lighting, one could reduce the amount of shadow cast when a teacher or child writes on the front blackboard or on a desk surface. These lights help to create a softer, more diffuse light environment throughout the room, thereby alleviating glare.

Conclusion

Although recent research has been conducted regarding classroom illumination factors, continued study is warranted. there is also an urgent need to relate existing findings to educational practice. Granted, the measurement of the success of suggested classroom modifications is based on trial and error judgments which can be expensive presenting a problem for the school administrator. However, as educators we have the responsibility to ensure that our message is getting across to our hearing-impaired students. The effects of other optical variables such as color, movement, and surface contrast are more subtle than lighting, and more empirical evidence is needed to specify the optimal use of these factors in visual communication (see Nuckolls, 1976). A case may be made also for the implementation of vision screening programs in schools for the deaf (Levin and Erber, 1976). After all, the receptor in the optical environment is important too! In summary, the environments of classrooms for hearing-impaired children deserve more attention then they have previously received. I hope to see continued study regarding this subject in the future.

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