PREDICTION OF SPEECH PERCEPTION FROM THE ACOUSTIC CONDITIONS OF UNOCCUPIED CLASSROOMS

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ABSTRACT

It is well recognized that the acoustical environment in a classroom is an important variable in the psycho educational achievement of hearing- impaired children. For teens and young adults having normal speech processing in noise, ambient noise levels nor exceeding 40 dBA are suggested as acceptable, and reverberation times of about 0.6 are concluded to be optimum. Hearing- impaired children may require levels of ambient noise and reverberation times as low as only 21,5 dBA and 0,4 s respectively. The purpose of this study was to measure reverberation times, background noise levels and Speech Audibility Index (SAI) values in unoccupied classrooms. Estimations of speech perception were established for simple and complex sentences with familiar and unfamiliar content. In one-third or the classrooms the reverberation times were found to be longer than 0.9 s. at one or more frequencies ranging from 250 Hz to 8 kHz. In most of the unoccupied classrooms, the background noise level was 45db (A) or less. Most classrooms had SAI values that reflected fair intelligibility, but very few classrooms had SAI values indicating excellent intelligibility. Educational implications of theses data, such as acoustical modification of the classroom and/or the utilization of frequency modulation sound field amplification systems, are discussed.

INTRODUCTION

Accurate transmission of acoustical information in classrooms is very important for optimal academic achievement. Unfortunately, speech perception ability in a classroom setting can often be deleteriously affected by the acoustical characteristics of that environment. Speech perception can also decrease by reductions in the child's hearing sensitivity or auditory processing.

Acoustical variables that can compromise perceptual abilities include: the classroom's Reverberation Time (RT); the overall level of background noise; the relationship between the level of the teacher's voice and the background noise and the distance from the teacher to the child. RT is defined as the time (in seconds) it takes for the sound from a source to decrease in level by 60 dB after the source has stopped. Background noise is defined as any undesired auditory stimulus that interferes with what a child wants, or needs, to hear and understand. According with ANSI, background noise level cannot exceed 40 dB (A) and reverberation time should not exceed 0.6 s.

The Speech Audibility Index (SAI) specifies the proportion of useful acoustic information available to the listener. This index is derived from the acoustic conditions of the classroom. SAI allows the estimation of speech perceptual abilities such as the recognition capacity of words of different lexical complexity and sentences of different syntactical complexity for both normal and impaired hearing children

In this study, we try to measure reverberation times, background noise levels and Speech Audibility Index (SAI) values in unoccupied classrooms. As well as an estimation of speech perception of phonemes, words and sentences is carried out for normal and impaired hearing children.

METHOD

CHARACTERISTICS OF THE CLASSROOMS

A total of 25 unoccupied elementary school classrooms were chosen. In general, the physical characteristics of the classrooms were very similar. Most of them had granite flooring without carpets, concrete ceilings, windows without appropriate acoustic insulation and blackboards on walls.

PROCEDURE

In all classrooms, the length, height and width of the classrooms was determined in order to establish the volume. Reverberation time and background noise level was also measured.

An estimation of the speech recognition for normal and impaired hearing children was obtained from the simulation of the acoustic conditions of the average classroom. This simulation was carried out with the Sound Field Wizard Software. This software can estimate the speech recognition of words in simple or complex sen-

tences, and words frequently and infrequently used in isolation.

RESULTS

The average classroom is 6 m wide, 10m long, 3m high. It has a volume of 180 m^3 and a SAI of 52%. Reverberation time measurements ranged from 0.6 to 1.2 s. Out of the 25 classrooms, 24 exceeded the ANSI S12.60 maximum recommended reverberation time of 0,6 s.

The Noise Rating Curves were developed by the International Organization for Standardization (ISO) to determine the acceptable indoor environment for hearing preservation, speech communication and annoyance. A NRC of 35 is recommended for schools, libraries, museums and other similar purposes. In this study, for the 24 classrooms studied, 4 of them exceeded the ISO maximum recommended NR of 35 dB.

Predicted speech recognition for normal and impaired hearing children was calculated as 52% SAI. In general, normal hearing children have a 95% of correct speech recognition for words in complex sentences. Hearing impaired children obtained 49% correct speech recognition.

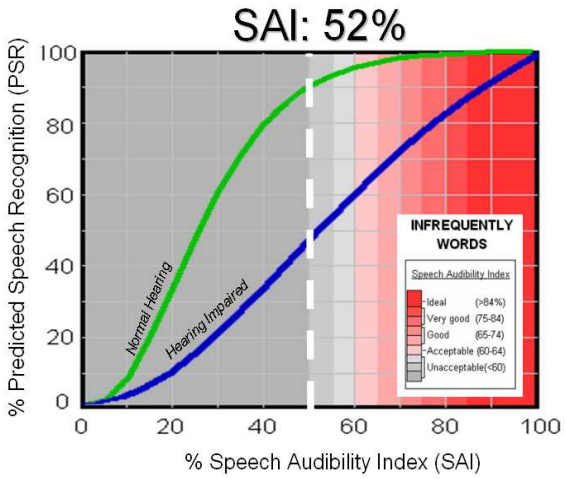

Figure 1: *The acoustic conditions of the average classroom studied were unacceptable. A Speech Audibility Index of 52% was obtained for the mean of the 24 classrooms studied. The estimated percentage of speech recognition of infrequent words for normal hearing subjects under these acoustic conditions was 90 % and 48% for subjects with 60 dB hearing-loss impairment.*

CONCLUSIONS

In conclusion, we can say that in all classrooms studied Reverberation Time Levels are distant from the recommended values. Background Noise Levels are acceptable for most classrooms studied. With 52% SAI, subjects with hearing-loss have significantly lower predicted speech recognition score than normal hearing subjects. FM system or acoustic modifications must be applied in order to improve intelligibility in the classroom studied.

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