SPEECH RECOGNITION IN NOISE BY HEARING- IMPAIRED CHILDREN USING FM SYSTEMS

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Abstract

The typical classroom presents a very difficult listening situation for a child with hearing impairment. Background noise, reverberation and distance from the speaker can interfere with the accurate speech perception. Children with moderate to severe hearing loss routinely use personal frequency modulated (FM) systems in the classroom to improve the signal to noise ratio of teacher- directed speech with notable success. Speech recognition performance in noise was examined in hearing impaired children with cochlear implants (CIs) and Hearing Aids (HA) when using a frequency modulation (FM) system (a) with the FM microphone/transmitter on and off (b) in noise and in quiet (c) for words and sentences. Recognition of phonemes for lexically frequent and rare words and identification of correct words in simple and complex sentences was measured in 16 teenage students. The result showed that there were no differences in speech recognition between CI and HA users. FM benefit was present in both conditions quiet and noise but was somewhat greater in noise. Recognition of phonemes was high for lexical frequent words and for simple sentences. The findings confirm the value of FM amplification in both quiet and noise conditions.

Introduction

The accurate transmission of acoustic information in classrooms is an important issue for optimal academic achievement. Unfortunately, speech perception ability in a classroom setting can often be deleteriously affected by the acoustical characteristics of that environment. One of them is the signal-to-noise ratio.

The signal to noise ratio (SNR) is the relationship between the intensity of the signal and the intensity of the background noise in the child's ear. In the educational setting, hearing-impaired children need greater SNR than normal hearing children since classrooms are noisy places because speech perception is highest at favourable SNRs and decreases as a function of reduction in SNR.

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A FM system consists of two elements: a FM transmitter and the FM receiver that provides an audio signal to the audio input of the hearing instrument. This system offers a simple solution to the problems caused by talker's distance, reverberation time and background noise level. A microphone placed close to the mouth of the talker picks up speech at high intensity, with an excellent signal to reverberation and noise ratios.

In this study, we are going to review the benefits of the FM system in hearing- impaired children with hearing aids or cochlear implants. We try to establish the acoustics of the hearing-impaired classrooms and the profile of candidates to use the FM system.

METHOD

Subjects

In the study participated 16 subjects with ages ranging from 5 to 14 years old, 7 of them with unilateral cochlear implant and 9 with hearing-aids. Seven of them had bilateral hearing-aid fittings and the rest had unilateral hearing-aid fittings. The subjects were selected with a good capacity for speech discrimination.

Materials

Recognition of Frequently and Infrequently used words was examined in four acoustic conditions: with and without the FM system switched on; with and without background noise. Testing was carried out in the hearing-impaired children's classrooms. The background noise applied was the ICRA unmodulated random gaussian noise at a level of 55 dB SPL. Noise was produced from four loudspeakers positioned in the four corners of the room. The goal was to generate a uniform sound field in the room. Students were seated in the arc of a 3-metres radius circle centred at the talker's mouth. Test words were produced live by one of us. Speech level was 75 dB SPL at the teacher's microphone and 60 dB SPL at the students' location. When the noise was present, the corresponding signals to noise ratios were 20 and 5 dB, respectively

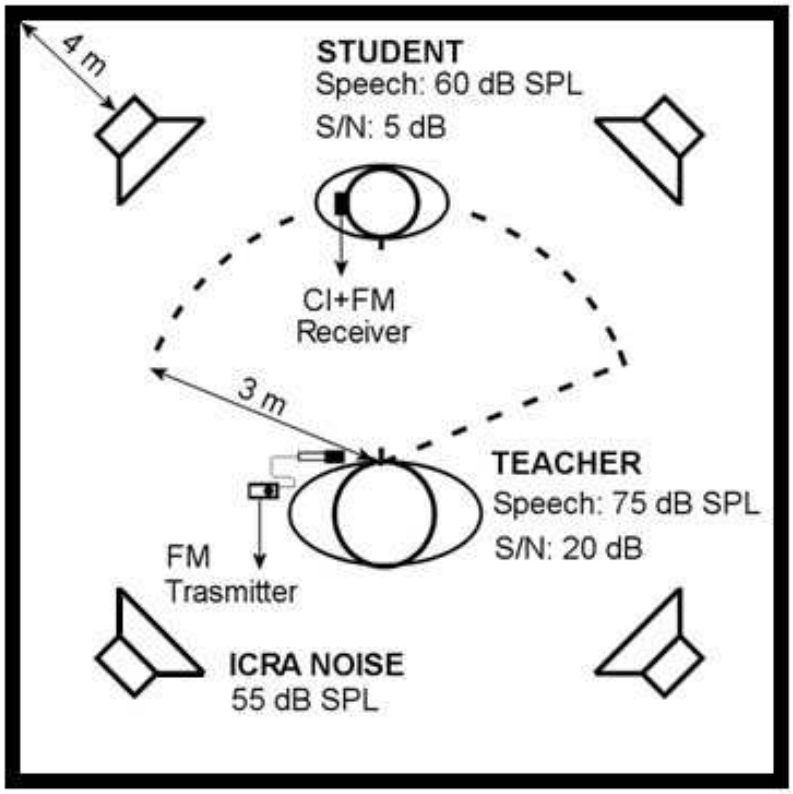

Figure 1. Diagram of the examination test procedure applied in the present study.

In general, frequently used words were more easily recognized than infrequently used words for all subjects studied. Significantly better speech recognition scores were obtained with the FM system than without FM system. Subjects with hearing-aids obtained better results than subjects with cochlear implants in all conditions. Better scores were also obtained with the FM system than without the FM system. Significant effects were obtained for lexical frequency and background noise factors. In this sense, better scores were found for frequently used words than for infrequently used words. Subject participants in this study obtained better scores in quiet than in noisy condition. The main benefit of the FM system is obtained for infrequently used words and noisy background conditions.

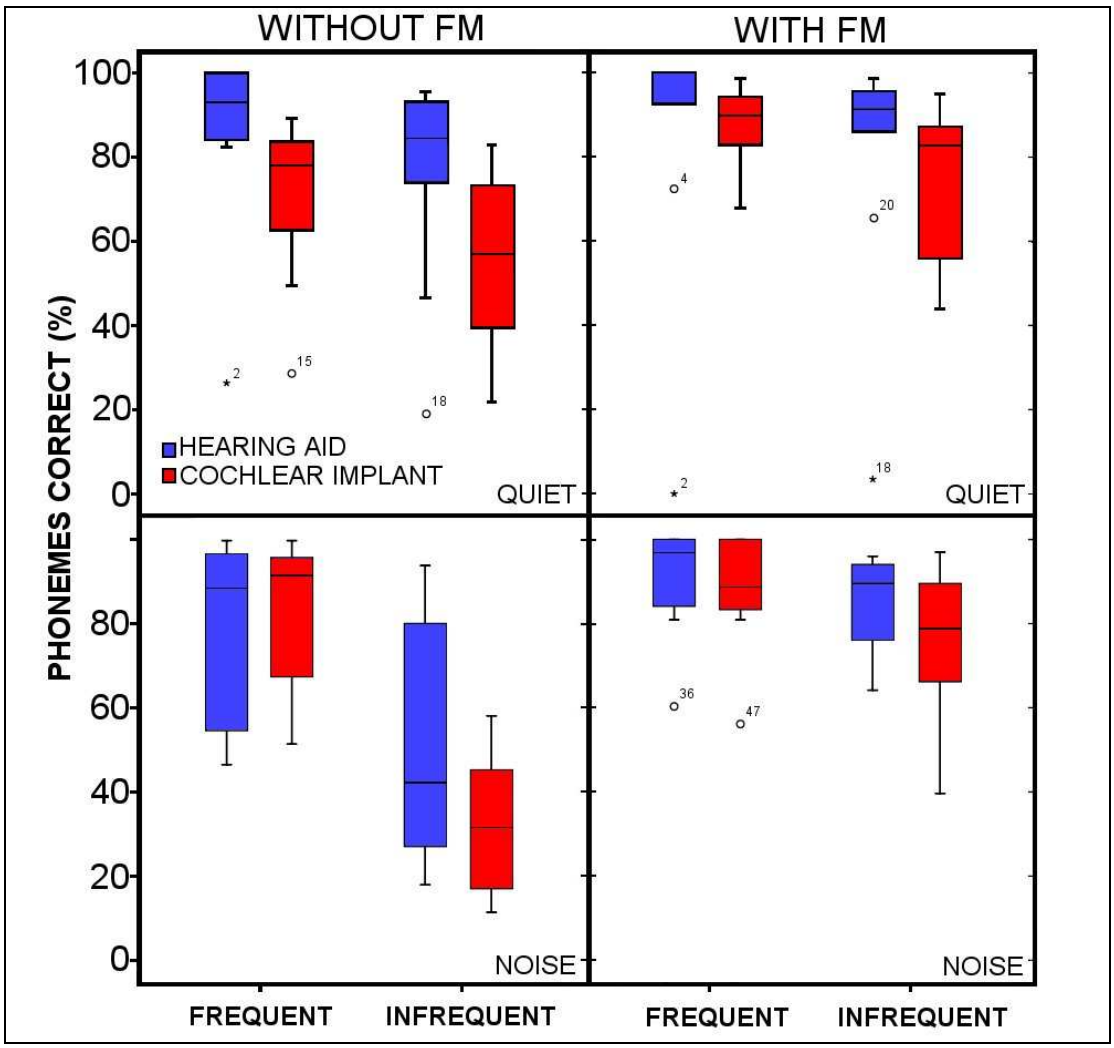

Figure 2. *Box Plot of phoneme recognition percentage according to lexical frequency in the four conditions examined in this study.*

Conclusions

Speech tests in noisy environments are a useful way to establish a selection criterion for FM-user candidates and verify the benefits of the FM system.

The benefits of the FM system can be established from the subtests for infrequently used words in quiet and noisy environments.

The recognition of words in noisy and quiet conditions allows us to establish a highly-accurate selection criterion and identify those subjects that can benefit from the FM systems.

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