FM SYSTEMS IN COCHLEAR IMPLANT USERS. BENEFIT OVER SPEECH RECOGNITION IN NOISE

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ABSTRACT
The use of frequency-modulated (FM) systems with cochlear implants has steadily increased as the FM technology has become more integrated with the cochlear implant speech processor. Although noise-reduction technology is incorporated into cochlear implants, this technology cannot compensate for the reduction in the speech signal that occurs as the distance from the speaker is increased. The use of FM systems with cochlear implants is most often addressed in educational environments in which the noise level may interfere with learning new information.

INTRODUCTION
The accurate transmission of acoustical environment in classrooms is an important issue for optimal academic achievement. Speech perception ability in classroom can often be adversely affected by acoustical characteristics of that environment (reverberation time, background noise level, signal to noise ratio).

It is well know that in the educational setting hearing impaired children needs greatest signal-to- noise ratio than normal hearing children since classrooms are noisy places.

FM systems offers a simple solution to the problems caused by acoustical characteristics of the classroom.

This study is going to review the benefit of FM systems in cochlear implant users.

METHOD
A total of 7 children with unilateral cochlear implant were studied. Ages ranged from 5 to 14 years old. Subjects were selected with a well capacity of speech recognition measure with a scale developed for this objective. All subjects have a score over 40%.

PROCEDURE
1.-Test Conditions
Students were tested in two conditions: in quiet and in noise. Both conditions were studied with and without the FM system. Noise was recorded multi talked babble. It was produced from four loudspeakers placed four meters from and facing the four corners of the room at 30 inches above the floor.

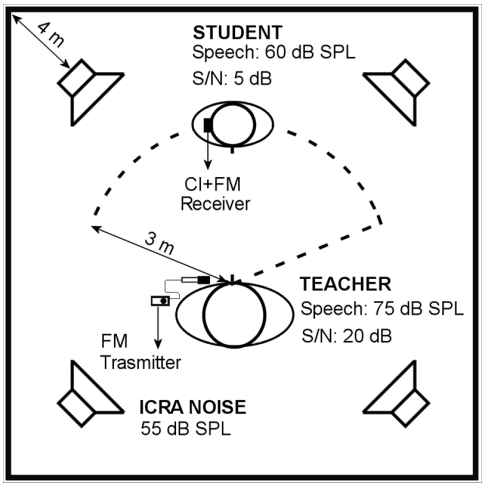
Average root-mean level was 55 dB SPL at the student location.

The student was seated in the arc of a circle of 3 meters. Test words were produced by one of us. Ensuring the students could not read lips.

Speech level was 75 dB SPL at the teacher microphone and 60 dB SPL at student location.

When the noise was present, the corresponding signal-to-noise ratio was 5 dB at the student location.

Fig. 1. Test Conditions.



2.- Speech Discrimination Test
The percentage correct phonemes recognition was determined in 4 conditions: with/without FM in quiet/noisy conditions. Each condition included one test list of 20 words divided between frequently and infrequently words.

RESULTS
An analysis of variance was carried over the data. In the following figure, we represent the box plot of the percent recognition of phonemes in function of the lexical frequency. In general, we obtained:

- Frequently words were easily recognized than infrequently words for all subjects
- Better results were obtained with the FM systems than without the FM
- Subjects with hearing aids obtains better results than subjects with cochlear implants in all conditions.

The ROC curves can provide information about the FM benefit. We have the percent score of phonemes recognition with and without FM. Subjects obtaining a score higher than 85% have a benefit with the FM system. However, the sensitivity and specificity is 62%.

Fig.2. Box plot of the percent recognition of phonemes in function of the lexical frequency.

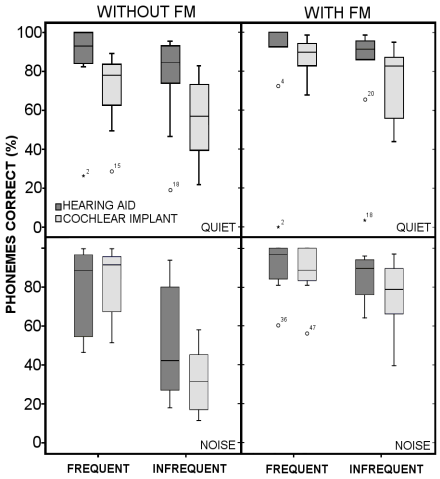
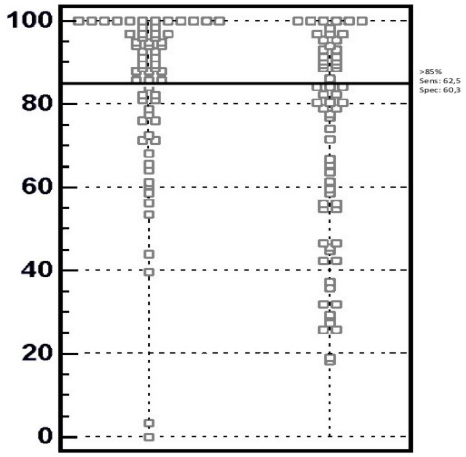
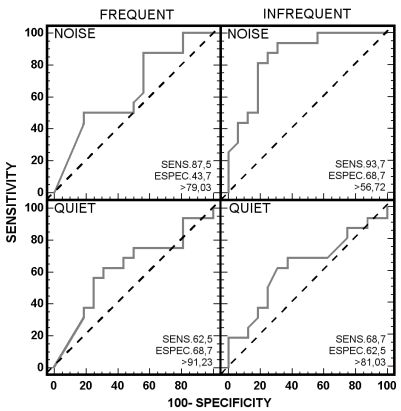


Fig. 3. ROC Curves representation: % score of phonemes recognition with and without FM.



The curves obtained for the frequently words show as no significant differences between noise and quiet conditions. Although, we obtained significant differences for the infrequently words in noise and quiet conditions.

Fig.4. ROC Curves representation.



CONCLUSIONS

1. Speech test in noise are a useful way to establish selection criteria candidates and to verify the FM system benefit.
2. FM benefit can be established from the infrequently used words in quiet and noisy subtest.
3. This subtest allow us to establish a selection criteria with a high accuracy and allow us to identify those subjects that can benefit from FM systems.

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