A VERIRFICATION PROTOCOL OF FM SYSTEMS FOR CHILDEN WITH COCHLEAR IMPLANT

Zenker Castro, F. [(1)], Mora Espino, R. [(2)], Rodríguez Jiménez, M.C. [(3)], Mesa Suárez, J.L. [(4)], Coello Marrero, A. [(4)], Suárez Rodríguez, M. [(3)] and Barajas de Prat, J.J [(3)]

[(1)] Fundación Canaria Dr. Barajas para la Prevención e Investigación de la Sordera [(2)] Clínica Barajas, [(3)] Universidad de la Laguna, [(4)] Consejería de Educación, Cultura y Deportes del Gobierno de Canarias.

ABSTRACT

Frequency modulated (FM) systems have been standard equipment for children with hearing loss in educational settings for many years. FM systems increase the signal to noise ratio through a microphone placed a few centimetres from the mouth of a talker and providing a wireless connection to the listener's Cochlear Implant (CI). The primary benefit of FM system is the resulting improvement of signal-to-noise ratio that allows the user to increase attention span, reduce distractibility, and increase sound awareness and discrimination.

The only way to ensure optimal connections and settings in a FM System is through systematic Speech Recognition Testing. Two parameters must be taken in account in order to fit a FM Systems to CIs. First, the appropriate audio mixing must be established through the Sensitivity of the microphone of the CI Speech Processor. Second, the FM Advantage must be adjusted in order to optimize loudness of the FM signal.

In this poster a verification protocol for fitting a Phonak Campus S to a Nucleus 24 Cochlear Implant is proposed. Evaluation of speech recognition benefit in noise with and without the FM system was carried out. The results confirm that the settings in both the CI and FM receiver are optimal.

VERIFICATION PROTOCOL

Children usually learn in classroom environments with background noise and excessive room reverberation (1). Nowadays, it is more frequent to find hearing-impaired children with CI in educational settings. Often, classroom acoustics are adequate for normal hearing pupils but absolutely inappropriate for hearing-impaired children with CIs (2). Implanted children complain about difficulties in understanding teachers in that situation. The negative influence of noise on speech perception by cochlear implant users may be due to the following factors: the speech processor codifies the signal to a stimulation pattern of electrodes in a quiet environment, which varies when there is noise (3); signal processing in the cochlear implant system reduces information and signal redundancy (4); monaural input to the hearing system consisting of one single microphone connected to the speech processor does not allow processing noise reduction, which is possible in the binaural auditory system (5).

Frequency modulated (FM) systems are used to improve the signal-to-noise (S/N) ratio by placing on the teacher a microphone transmitter that delivers an amplified signal over FM radio waves to a receiver. The receiver delivers the amplified signal to the child's CI via a personal FM system. This manner of amplification of the teacher's voice provides a consistent signal regardless of the distance between the student and the teacher within the classroom setting.

FM systems are widely used by children wearing cochlear implants. However, there have been few studies about the benefits FM systems provide. Because there are many types of speech processors and FM receiver arrangements, the options for signal levels are numerous (6). Verification protocols through electro-acoustic measures, as done with hearing aids, are not possible with CIs. Adjustment of FM Systems must be carried out through systematic speech recognition measures in quiet environments and with background noise (7). In the following lines a protocol in six steps is proposed in order to adjust FM loudness in relation to environmental input and to confirm FM benefit.

1. SPEECH PROCESSOR SETTING

SPrint monitor earphones were used to verify operation of the Phonak Campus S FM transmitter and MicroLink CI+FM receiver when connected to the speech processor. The sensitivity control on the Nucleus devices with audio mixing is a crucial variable in FM benefit. This includes most of the 22 Nucleus sound processors and all sound processors for Nucleus 24. This sensitivity adjustment controls the input from the headpiece microphone, ultimately varying the audio mixing ratio between the cochlear implant microphone and the FM system. This control allows users to adjust the FM advantage to match conditions. In general, reducing the processor's sensitivity will result in greater FM advantage due to reduced input through the microphone of the cochlear implant. Children often prefer higher FM sensitivity in order to monitor their environment and their own voice. The present verification protocol must be run under normal 12 sensitivity parameters. Optimal sensitivity adjustment must be reviewed in step 6.

2. FM SYSTEM SETTING

The MicroLink interface has a wheel gain control fixed at 80%. Changes in FM advantage are achieved by programming the internal gain through Phonak FM Successware software.

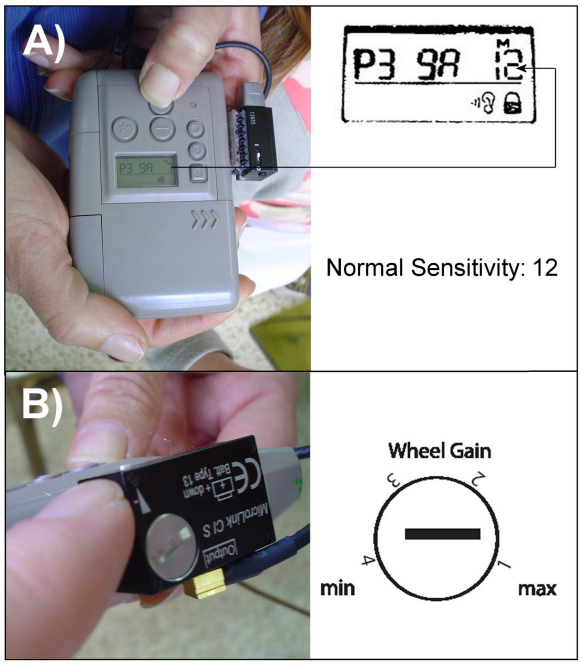

Figure 1: (A) Setting of the speech processor. The present verification protocol must be run under normal 12 sensitivity parameters. (B) Setting of the MicroLink receiver. Gain is fixed at 80% of the total wheel control.

3. TESTING ARRANGEMENTS

Testing is carried out in the child's classroom. Noise is recorded through multi-talker babble from the ICRA CD 1 Track 7. Loudspeakers are placed 1m from and facing the four corners of the room at 75 cm above the floor. The average root-mean-square (rms) noise level is 55 dB SPL at the student locations. Students are seated in the arc of a 3-metre radius circle, centred at the talker's mouth. The FM microphone is placed on the talker's chest at 30 cm from his mouth. Speech level measured was 74 dB SPL at the teacher's microphone and 60 dB SPL at the student location.

4. SPEECH MATERIAL

Speech perception is measured in two conditions: percentage of phonemes recognized in a list of frequent and infrequent words and percentage of words recognized in a list of complex and simple phrases. Results are individually analyzed by computer software.

5. FM BENEFIT

Figure 2 shows the results of a single case. The FM benefit is established by assessing the difference of the data obtained with and without FM. In this case, a clear benefit is obtained with the FM system as it is reflected in the Speech Reception Testing Scores.

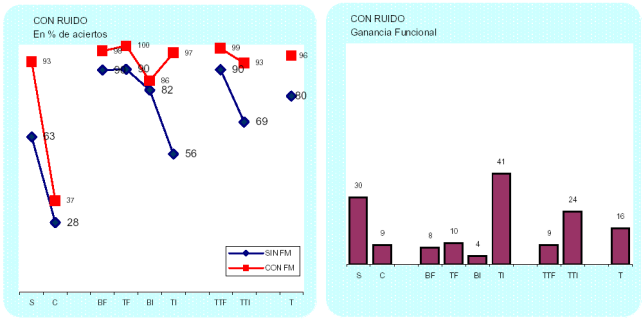

Figure 2: Results of a single case. FM benefit established for noise condition with and without FM system. On the left, Speech Reception Testing Scores for frequent and infrequent words. On the right, the systems' Functional Gain is established from the differences between scores obtained with and without FM.

6. FINE TUNING

If the child's performance does not improve compared to using the CI alone, the ratio between FM input and the headpiece microphone may need to be adjusted. In general, reducing the processor's sensitivity will result in a greater FM advantage as a result of reduced input through the CI microphone. Care should be taken in order not to reduce excessively the input of the CI microphone to avoid the isolation of the child from his peers. If this is the case, the gain of the MLxS receiver must be changed in order to increase the FM advantage as described in step 2.

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