Roger and cochlear implants

Significant speech understanding in high noise levels

A recent study by Dr. Jace Wolfe of Hearts for Hearing Foundation, Oklahoma City, revealed that the usage of Roger systems in combination with cochlear implants resulted in significant improvements in speech recognition at high noise levels (70, 80 dB (A)) over traditional and Dynamic FM technologies.

Objective

The purpose of the study was to compare the performance of Roger wireless microphone systems against that of no FM, traditional FM and Dynamic FM via objective measures of speech recognition in quiet and at different noise levels.

Design

Measurements took place in a classroom setting. Sentence recognition in quiet and in noise was evaluated using three types of wireless microphone system and without FM. Noise levels and technology type were randomized. Participants and examiners were blinded to the technology type throughout the experiment. For full details of the test set-up see Figure 1.

Sample

37 CI users participated in the study, using a mix of Advanced Bionics (AB) and Cochlear CI solutions. The average age of subjects was 46.4 years with ages ranging from 8 to 81 years. All participants had owned their CIs for at least three months, and both unilateral and bilateral CI users were included in the study. If unilateral CI recipients used a hearing instrument on the contralateral ear, this hearing instrument was switched off but left inserted in the ear during testing (in order to prevent the contribution from the hearing instrument ear from confounding the primary objective of evaluating different wireless technologies with CIs). All participants achieved open-set speech recognition in quiet of at least 50% correct on monosyllabic words. AB recipients (N=16) used Harmony sound processors; Cochlear Nucleus recipients (N=21) used the Nucleus 5 (CP810) sound processor. The radio receivers were coupled to the iConnect FM earhook of the AB sound processor and to the EuroAdapter of the Nucleus sound processor. The audio-mixing ratio of the sound processors was set at 50/50 and 1:1 for the AB and Cochlear subjects, respectively. Previous research has indicated that these mixing ratios are most appropriate for listeners using CIs, because access to environmental sounds is not compromised when the processor microphone is not attenuated.

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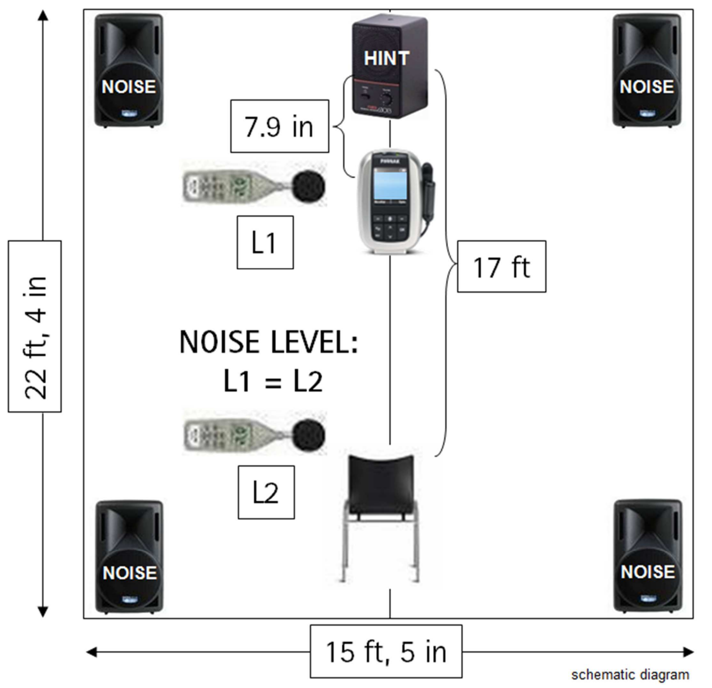

Fig. 1 Speech recognition measurements were conducted in a classroom featuring four speakers, placed at the corners, to present classroom noise, and another at the front to deliver the speech.

In the processors of all Cochlear recipients ASC+ADRO was enabled. AB users who were using the HIRES Fidelity 120 signal coding strategy (N=12) were tested with the ClearVoice input processing strategy. AB users who did not use HIRES Fidelity 120 were tested while using their typical signal coding strategy without ClearVoice. In the study three different radio receivers were used: a Phonak MicroMLxS with a fixed FM Advantage of +10 dB, a Phonak MLxi Dynamic FM receiver with an adaptive FM Advantage which is increased automatically for ambient noise levels above 57 dB(SPL), and a Phonak Roger receiver, with adaptive gain controlled by digital signal processing. The Phonak inspiro Dynamic FM and Roger transmitter captured the speech stimuli and relayed the signal to the aforementioned receivers.

Speech recognition was evaluated using randomly-selected lists of HINT sentences, presented at 64 dB(A) at the location of the subject. Multiclassroom noise, recorded from a first-, second-, third-, and fourth-grade school classroom during independent work time, was digitally overlapped and served as the competing noise signal (Schafer and Thibodeau 2006). This competing signal was presented at 50, 55, 60, 65, 70, 75 and 80 dB(A) when measured at the position of the subject's head. A second measurement of the noise level at the position of the transmitter microphone ensured that the noise level at that position was no different. The quiet condition and the seven noise levels, without wireless technology and with the three different types of wireless systems, accounted for a total of 32 conditions.

Results

The average speech-recognition scores are shown in Figure 2 (AB users) and Figure 3 (Cochlear users). Statistical analysis (ANOVA) revealed no significant main effect of CI manufacturer, a significant main effect of wireless device technology ($p<0.00000$) and a significant main effect of noise level ($p<0.00000$). The best performance was obtained with Roger, followed by Dynamic FM (MLxi) and traditional FM (MLxS). At the highest noise level of 80 dB(A), traditional FM failed to provide enough improvement in speech recognition to differ significantly from the no-wireless condition.

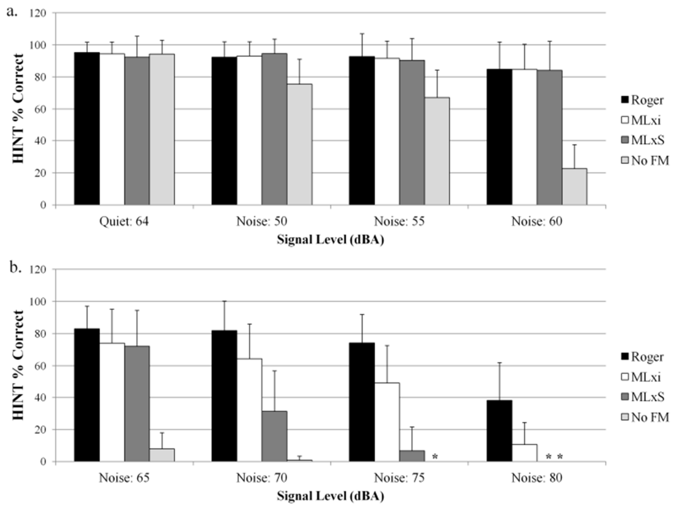

Fig. 2 Speech recognition results for the users of AB Harmony sound processors in quiet, in low levels of noise (a) and in higher levels of noise (b). The speech signal was presented at 64 dB(A) at the location of the subject. The noise level is indicated on the x-axis of the figure. MLxi is Dynamic FM and MLxS is traditional FM technology. HINT=Hearing in Noise Test.

As expected, no differences were observed in sentence recognition in quiet across any of the test conditions, including the no-FM condition. The speech signal reached the user at a level of 64 dB(A), and as a result, performance likely reached asymptotic levels, even without the wireless system. At all of the higher noise levels (70, 75, 80) Roger provided significantly better speech recognition in noise when compared to performance obtained with traditional FM, and at the 70 and 80 dB(A) noise levels, Roger provided better performance than Dynamic FM. Dynamic FM did, however, provide better speech recognition in noise than traditional FM at the 75 dB(A) noise level.

In summary, the difference in speech recognition in noise between Roger and Dynamic FM as compared to traditional FM became greater, for the most part, as the competing noise level increased (70 to 80 dB(A)).

Conclusion

Roger wireless technology results in significantly improved speech recognition in noise compared to Dynamic FM technology in high levels of noise. The difference in performance obtained with analog and Roger wireless systems are likely attributable to multiple factors. First, digital signal processing potentially allows for better analysis of the competing noise signal and a more accurate provision of receiver gain when compared to analog processing. It is possible that an improvement in the precision of the magnitude of gain increase provided by digital signal processing resulted in better performance in noise.

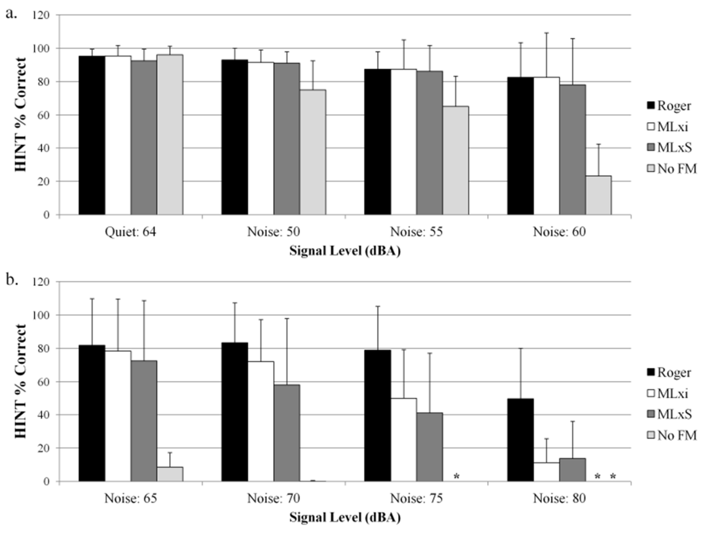

Fig. 3 Speech recognition results for the users of Cochlear Nucleus 5 sound processors in quiet, in low levels of noise (a) and in higher levels of noise (b). The speech signal was presented at 64 dB(A) at the location of the subject. The noise level is indicated on the x-axis of the figure. MLxi is Dynamic FM and MLxS is traditional FM technology. HINT=Hearing in Noise Test.

Second, Roger allows for a wider bandwidth of the audio signal. Previous studies have shown that a wider audible bandwidth may be associated with better performance in noise, particularly in noisy situations. Finally, the frequency-hopping approach used by Roger may have reduced the chances of interference between the signal transmitted from the personal wireless system and the signal transmitted from the coil of the implant's external sound processor to the receiving coil of the internal implant. Anecdotal experience has suggested that some CI users have complained of static or interfering noise while using personal FM systems with their CIs. It is well-known that digital radio systems that use adaptive frequency hopping reduce the likelihood of interference.

References

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