Field Study News

Dynamic FM and Cochlear Implants

Drastically Improved Speech Recognition in Noise

Abstract

Unlike traditional FM systems with fixed-gain settings, Dynamic FM automatically varies the gain of the FM receiver with changing ambient noise levels. The goal of the investigation (Wolfe et al, 2009) was to evaluate speech recognition of Advanced Bionics Corporation or Cochlear Corporation Cochlear Implant (CI) recipients using Dynamic FM vs. a traditional FM system and to examine the effects of autosensitivity on the FM performance of Cochlear Corporation recipients. A two-group repeated-measures design was used where participants were assigned to a group according to their type of CI. The use of Dynamic FM was considered to improve speech recognition in noise. Results showed that at default CI settings, FM performance is better for Advanced Bionics recipients when compared to Cochlear Corporation recipients, but use of Autosensitivity by Cochlear Corporation users results in equivalent group performance.

Introduction

Numerous studies conclusively demonstrate substantial improvements in speech recognition in noise when using personal frequency-modulated (FM) systems (Schafer and Thibodeau, 2004; Anderson et al, 2005; Wolfe and Schafer, 2008). Specifically, personal FM receivers improve speech-recognition performance of people with CIs by up to 50 percentage points when compared to the no-FM system condition (Wolfe and Schafer, 2008). For many people, this improvement results in similar performance to what was achieved in quiet. Furthermore, adults report a preference for the personal FM system when compared to their CI alone (Schafer and Thibodeau, 2004) and cite better clarity of speech with the use of an FM system (Wolfe and Schafer, 2008).

In 2008 Phonak introduced Dynamic FM, which features a proprietary component referred to as the Dynamic Speech Extractor. The Dynamic Speech Extractor adaptively varies the gain of the FM receiver depending on the level of noise at the microphone of the FM transmitter. When speech is presented to the FM microphone and ambient noise is less than 57 dB SPL, the default gain of the Dynamic FM receiver is set to +10. When ambient noise levels exceed 57 dB SPL, the gain of the FM receiver is increased by an amount that is proportional to the noise level. The maximum gain of the FM receiver is +24 at a noise-input level of approximately 75 dB SPL.

Another feature of Dynamic FM is the Voice Activity Detector. In quiet and in noisy environments, when speech is not present at the input of the FM microphone of the Phonak inspiro Dynamic FM transmitter, the receiver is muted to optimize listening comfort. This feature reduces the audibility of unwanted noise, which may be present in the form of "static noise" or a "rushing noise" that accompanies the primary FM signal.

The primary goal of this study was to examine the effects of Dynamic FM on speech recognition performance of people with CIs.

Test subjects and devices

In order to participate, subjects had to achieve open set speech recognition in quiet of at least 80 percent correct on Hearing in Noise Test sentences or 30 percent correct on monosyllabic words. These criteria were chosen because participants with poorer speech recognition are likely to have substantial difficulty with speech recognition in noise testing.

Twenty-four subjects, ranging from 8 to 82 years of age, participated in this study. Thirteen participants used the Advanced Bionics Corporation CII or HiRes 90K internal cochlear stimulator and one of the following external speech processors: (1) Platinum bodyworn processor, (2) CII behind-the-ear (BTE) speech processor, (3) Auria BTE speech processor, or (4) Harmony BTE speech processor. Five of these subjects had bilateral CIs. Eleven participants used the Cochlear Corporation Nucleus 24 or Nucleus Freedom internal cochlear stimulator with a Freedom BTE speech processor. Two of these subjects had bilateral CIs. Each subject was fit with a personal FM receiver and adaptor designed for his or her speech processor. The two different FM receivers used for study were the Phonak MicroMLxS (i.e., "traditional FM") and the Phonak MLxi receiver (i.e., "Dynamic FM"). Traditional FM is a receiver with a fixed gain setting (+10 in this study) that is predetermined by the clinician, while Dynamic FM is adaptive and automatically increases the gain setting with increasing noise level.

Results

Speech Recognition in Quiet: Average speech-recognition scores in quiet with the Dynamic FM were 87% and 87% for the AB and the Cochlear groups, respectively. A statistical analysis using a one-way analysis of variance revealed no significant difference. Therefore, speech recognition in quiet is similar for the two groups.

Speech Recognition in Noise: The average results for users of the AB and Cochlear implants in the two FM conditions are shown in Figure 1. A threeway, mixed-model repeated-measures ANOVA was used with one between-subjects factor, CI manufacturer (AB and Cochlear), and two within-subjects factors, FM system (traditional and Dynamic FM) and noise level (55, 65, 70, and 75 dBA). Statistical analysis revealed significant main effects of FM system, CI manufacturer ($p<0.0001$), and noise level ($p<0.001$). These results suggest that Dynamic FM provided significantly better speech recognition in noise than the traditional FM and that AB implants had significantly better performance than Cochlear implants in noise (Figure 1).

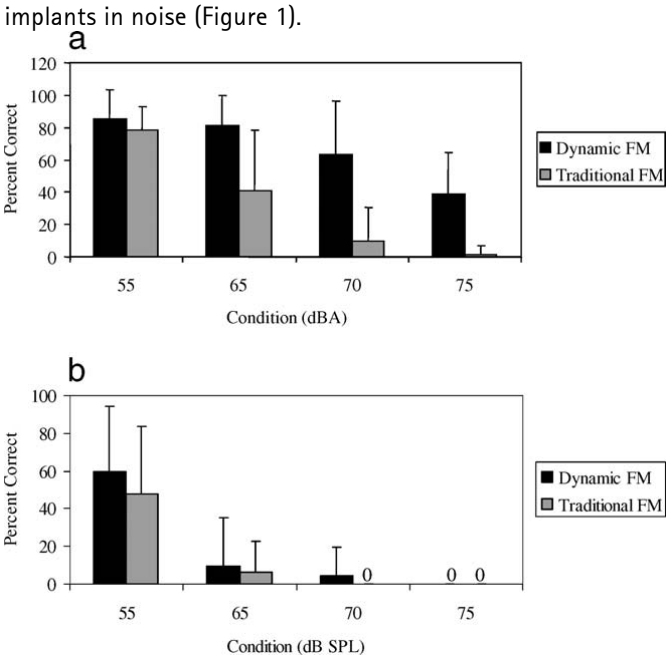

Figure 1: Speech recognition in noise for AB implant recipients at four different noise levels using traditional and Dynamic FM (a). Note: Lines represent 1 SD. b). Speech recognition in noise for Cochlear implant recipients at four different noise levels using traditional and Dynamic FM. Note: 0 = 0 percent correct.

Once the noise level was increased to 65 dBA or greater, the Dynamic FM provided significantly better speech recognition in noise than the traditional FM. The poorest performance was with the traditional FM in the 70 and 75 dBA noise conditions. The presence of a greater number of bilateral CI participants in the AB group (N=5), as compared to the Cochlear group (N=2) may have influenced these results. Some people with bilateral CIs receive an advantage for using two FM receivers when compared to one FM receiver (Schafer and Thibodeau, 2006). To examine this possibility, an additional ANOVA, using only the unilateral CI participants from the AB (N=8) and Cochlear (N=9) groups, was conducted. The analysis revealed the same significant main effects ($p<0.05$) and interaction effects ($p<0.05$) as the original analysis. Consequently, the additional benefit that may be achieved by some of the participants using bilateral implants and binaural FM did not influence the overall findings of this study.

In an attempt to optimize FM performance for persons using Cochlear Corporation CIs, ASC was enabled and the test procedures were repeated. The use of ASC significantly improved performance when compared to the no ASC conditions at the same noise levels. Dynamic FM data from Advanced Bionics subjects were compared to data from Cochlear Corporation subjects using Dynamic FM and ASC. As shown in Figure 2, the differences in speech recognition in noise between groups were no longer significant at any of the three noise levels.

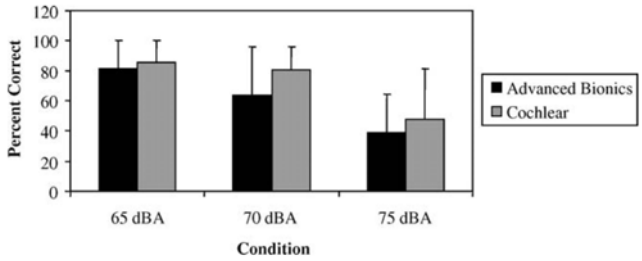

Figure 2: Speech-recognition performance with Dynamic FM: Advanced Bionics Corporation users vs. Cochlear Corporation users set to Autosensitivity *Note*: Lines represent 1 SD.

Conclusion

The results indicate that the participants achieved significantly better speech recognition in noise with Dynamic FM as compared to their performance with traditional FM. In other words, adjusting the FM receiver gain according to the noise level in the environment allowed the user better access to the FM signal than the fixed-gain receiver. Dynamic FM provides the user with a more favorable signal-to noise ratio, which improves audibility and intelligibility of the signal from the FM system. Dynamic FM may also be helpful in quiet environments because the FM gain is negligible, which limits audibility of FM artifacts and reduces battery current drain. These findings are similar to those of previous studies that have shown that manually increasing the gain in traditional FM systems significantly improve performance for AB CI users but not for Cochlear users (Schafer et al, in press). Even with the fixed-gain, traditional FM receivers, users of AB implants had significantly better scores than Cochlear recipients when Cochlear users were evaluated with recommended map parameters. The Cochlear Corporation group had substantially lower scores with both types of FM systems because of the poor performance at the 65, 70, and 75 dBA noise levels.

Differences in performance between the two manufacturers are likely attributable to differences in IDR between the two systems. To diminish these performance discrepancies, ASC should be enabled to optimize speech recognition in noise through the FM and speech processor (i.e., environmental microphone). Once ASC is enabled, users of Cochlear Corporation implants will gain significant advantages from using Dynamic FM when compared to traditional FM.

References

Anderson KL, Goldstein H, Colodzin L, Iglehart F. (2005) Benefit of S/N enhancing devices to speech perception of children listening in a typical classroom with hearing aids or a CI. J Educ Audiol 12:14–28.

Schafer EC, Thibodeau LM. (2004) Speech recognition abilities of adults using CIs interfaced with FM systems. J Am Acad Audiol 15(10):678–691.

Schafer EC, Thibodeau LM. (2006). Speech recognition in noise in children with CIs while listening in bilateral, bimodal, and FM system arrangements. Am J Audiol 15:114–126.

Schafer EC, Wolfe J, Lawless T, Stout B. Effects of FM receiver gain on speech-recognition performance of adults with CIs. Int J Audiol. 2009 Apr;48(4):196-203.

Wolfe J, Schafer EC. (2008) Optimizing the benefit of AuriaH sound processors coupled to personal FM systems with iConnect*2* adaptors. J Am Acad Audiol19(8).

Wolfe J, Schafer EC, Heldner B, Mülder H, Ward E, Vincent B.. *Evaluation of Speech Recognition in Noise with Cochlear Implants and Dynamic FM". J Am Acad Audiol 20:409-421 (2009)

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