Contributing Factors to Improved Speech Perception in Children Using the Nucleus 22-Channel Cochlear Prosthesis


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Introduction

It has been established that use of multiple-channel intracochlear implants can significantly improve speech perception for postlinguistically deafened adults [1]. In the development of the Nucleus 22-channel cochlear implant, there have been significant developments in speech processing strategies, providing additional benefits to speech perception for users [2]. This has recently culminated in the release of the Speak speech processing strategy, developed from research at the University of Melbourne [3]. The Speak strategy employs 20 programmable bandpass filters which are scanned at an adaptive rate, with the largest outputs of these filters presented to up to ten stimulation channels along the electrode array. Comparative studies of the Speak processing strategy (in the Nucleus Spectra-22 speech processor), with the previously-used Multipeak (Multipeak) speech processing strategy (in the Minisystem-22 speech processor), with profoundly deaf adult cochlear implant users have shown that the Speak processing strategy provides a significant benefit to adult users both in quiet situations and particularly in the presence of background noise [4].

Since the first implantation of the Nucleus device in a profoundly hearing-impaired child in Melbourne in 1985, there has been a rapid growth in the...
number of children using this device. Studies of cochlear implant benefits for children using the Nucleus 22-channel cochlear implant have also shown that children can obtain significant benefits to speech perception, speech production and language, including open-set understanding of words and sentences using the cochlear implant alone [5-9]. In evaluating contributing factors to speech perception benefits available for children, four specific factors are important to investigate: (1) earlier implantation – resulting from earlier detection of deafness; (2) improved hardware and surgical techniques – allowing implantation in infants; (3) improved speech processing, and (4) improved habilitation techniques.

Results reported previously have been recorded primarily for children using the Multipeak strategy implemented in the MSP speech processor. While it is important to evaluate the factors which might contribute to improvements in speech perception benefits, an important question is the effect of improved speech processing strategy, since this will determine what is perceived through the device. Given that adult patients changing to the Spectra speech processor had also shown improved perception in noisy situations, and the fact that children are in general in noisy environments in the classroom setting for a large proportion of their day, it was of obvious interest to evaluate the potential for benefit in poor signal-to-noise ratios from use of the Speak processing strategy and from specific training in the ability to perceive in background noise.

The study was aimed at evaluating whether children who were experienced in use of the Multipeak speech processing strategy would be able to changeover to the new Speak processing strategy, which provides a subjectively different output. Secondly, the study aimed to evaluate the benefits which might accrue to children from use of controlled habilitation in background noise.

Methods

Seven children participated in the study. These children were all patients of the University of Melbourne/Royal Victorian Eye and Ear Hospital Cochlear Implant Clinic. All of the children had more than 1 year of experience with the Multipeak processor, and had achieved implant-alone scores on open-set word and sentence materials. In addition, all of the children were in the age range of 6-14 years. No other specific selection criteria were applied, and the children varied in etiology, length of profound deafness preimplant, residual hearing thresholds, age at onset, and experience with the device. These children represented a reasonable crosssection of the pediatric population.

The children were evaluated with open-set Speech Intelligibility Test (SIT) sentences, scored by key words (50 per list). In all cases, testing was live-voice, using a consistent speaker throughout the test procedures for each child. Children wrote their response to each test item, or if this was not possible, the responses were videotaped and indepen-
Figure 1 shows speech perception scores on the SIT sentences in background noise for the 7 children. As shown, 6 of the 7 children showed significant improvements in speech perception scores when using the Speak processing strategy as compared with Multipeak. Only 1 child did not show an improved speech perception ability with Speak. It was also evident that improvements in speech perception continued to increase with additional experience with Speak.

In the second study, 4 children participated in a pilot study during which they received habilitation in background noise for 15 minutes/session, 2 sessions/week. The signal-to-noise ratio varied for each child across the range of +5 to +15 dB SPL. The children were assessed on perception of CNC words in background noise before and after 6 months of habilitation.

Results

Figure 1. Implant-alone scores on SIT sentences for 7 children using the Multipeak and Speak processing strategies in background noise (+15 dB SIN ratio). *p = 0.05.

Each implanted child develops auditory skills that will be influenced by diverse factors such as the cause of deafness, age at onset of hearing loss, length of profound deafness prior to implantation, age at implantation, degree of residual hearing present preoperatively, presence of other handicaps or diseases affecting the central auditory system, and cognition, number of sessions in the cochlea, experience and support from family, professionals, innate characteristics of auditory memory, neural auditory pathways, auditory attention, as well as the motivation and personality of the child. In this learning process in the children, they influence the learning of normal hearing.

The clinic's third aim is to maximize the potential for the implanted child to improve speech perception and articulation.
experience. Mean scores for the group were also significantly higher with Speak as compared to Multipeak.

Figure 2 shows results on CNC words in background noise for the 4 children who participated in the controlled habilitation in background noise study. As shown, all 4 children showed improved perception scores following habilitation in background noise.

Discussion

The results suggest that children who have previously used the Multipeak speech processing strategy in the Nucleus Mini-22 multichannel cochlear implant are able to change to the new Speak processing strategy implemented in the Spectra-22 speech processor, and that speech perception benefits may be improved through use of the advanced strategy. As indicated in the data presented in figure 1, and as presented in more detail elsewhere [10], the Speak processing strategy would be of benefit to a large proportion of the children currently using the Multipeak strategy, as benefits were available in both quiet and in the presence of background noise, which is more representative of the communication environment experienced by children at school. It is also of note that following completion of the study all of the 12 children chose to re-
tain the Speak processor. This included the child who did not score at a higher level with Speak, who was adamant in preferring the Speak processing strategy. Follow-up testing showed that 5 of the children continued to show improvements in speech perception benefits following additional experience with the Speak processing strategy.

The results for the habilitation in background noise study suggest that children might benefit from a specific program of habilitation which is focused on improving the children's listening skills in noisy environments. The results also suggest that children, using the Speak processing strategy, will be able to show improved perception in background noise.

References


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