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 produc­
tion 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 im­
portant to investigate: (1) earlier implantation – resulting from earlier detec­
tion of deafness; (2) improved hardware and surgical techniques – allowing im­
plantation in infants; (3) improved speech processing, and (4) improved
habilitation techniques.

Results reported previously have been recorded primarily for children us­
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 chil­
dren 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 experi­
enced in use of the Multipeak speech processing strategy would be able to
changeover to the new Speak processing strategy, which provides a subjec­
tively different output. Secondly, the study aimed to evaluate the benefits
which might accrue to children from use of controlled habilitation in back­
ground noise.

Methods

Seven children participated in the study. These children were all patients of the Uni­
versity 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, re­
sidual 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) sen­
tences, scored by key words (50 per list). In all cases, testing was live-voice, using a consis­
tent 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 ability continued to increase with additional 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 SN ratio).

* indicates a significant improvement between Multipeak and Speak processing strategies, 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 successes in the cochlea, experience with communication modes, editing, and the consistency of and support from family and professionals. Innate characteristics such as auditory memory, neural pathways, auditory attention, as well as the motivation and personality, 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.
Fig. 2. Implant-alone scores on CNC words in background noise for 4 children following controlled habilitation in background noise (+15 dB S/N ratio).

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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Title:
Contributing factors to improved speech perception in children using the nucleus 22-channel cochlear prosthesis

Date:
1997

Citation:

Persistent Link:
http://hdl.handle.net/11343/27570