Speak session 3 (9 weeks post-change), only 2 children still had Speak scores lower than Mpeak scores. At Speak session 8 (24 weeks post-change), 11 of the 12 children had Speak test session scores that were higher than their Mpeak scores. Child MA had a score for this session which was similar to the Mpeak average. Results of Mpeak and Speak evaluations measured at 3-weekly intervals for individual materials are shown for 4 different children in the Figure, to illustrate the different patterns evident in the results. The Figure, A, B, illustrates the case in which there was either an increase or no change immediately post-changeover. The Figure, C, shows results on CNC words that illustrate the pattern of a decrement in Speak session scores that were higher than their Mpeak scores. At Speak session 8, the Figure, D, shows the pattern for child MA, in which there was a decrement in performance with Speak that was evident across all Speak evaluations.

**DISCUSSION**

The results show that children who have previously used the Mpeak 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 with a very short period of adaptation. Scores for 8 of the children showed a small decrement over the first 3 to 6 weeks. However, by 24 weeks post-change, 11 of the 12 children showed similar or higher overall speech perception ability when using the Speak processing strategy. It was also of interest that improvements were noted both for children who scored in both the higher range (over 70%) and the lower range (less than 30%). The single child in the study who did not show benefit is of interest, in that she showed a similar pattern when changing from FOFIF2 to Mpeak, and a period of approximately 12 months was required before scores with Mpeak equaled those with FOFIF2.

As indicated in the data in the Table and elsewhere (Cowan et al, unpublished observations), the Speak processing strategy would be of benefit to a large proportion of the children currently using the Mpeak strategy, as benefits were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 retain 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. These children will now be followed up after further experience with Speak to evaluate whether benefits will continue to increase or plateau.

**REFERENCES**


**VOWEL IMITATION TASK: RESULTS OVER TIME FOR 28 COCHLEAR IMPLANT CHILDREN UNDER THE AGE OF EIGHT YEARS**

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**INTRODUCTION**

With increasing numbers of implanted children under the age of 4 years, numerous researchers have reminded us of the need for valid, sensitive, and reliable tests of developing speech perception. In addition to studies of the efficacy of implanted prostheses, there is a need to investigate the many variables that influence children's communicative performance, such as changes in speech-coding strategy, updated speech-processing systems, the effects of various training regimens, and the selection of educational and communication modes.

Current pediatric speech perception protocols may be cognitively and/or linguistically inappropriate for profoundly hearing-impaired children as young as 2 years of age. Many current test procedures require the subject to listen to the stimulus item, retain it in memory, discriminate from a choice of two or four pictures, then select, via a pointing response, the correct picture. Such closed-set testing is cognitively too demanding for many young subjects. An alternative to closed-set tests is open-set test procedures. These tests require the child to listen to the stimulus item, then repeat it or write the response. This type of testing is often complicated by the child's speech production and language ability.

Boothroyd describes a number of test procedures for use with children as young as 3 years of age. All require, however, verbal knowledge and the cooperation of the child to make a verbal or pointing response on demand. Boothroyd acknowledges that these methods are not suitable for the untrained child with congenital deafness or deafness acquired at an early prelingual age. A brief review of the most widely used tests of speech perception reveals that none are suited to the assessment of the congenitally profoundly deaf child under 4.
This paper aims to measure speech perception performance for young implanted children. The Vowel Imitation task was developed in Melbourne to assess the speech perception ability of hearing-impaired children as young as 2 years of age. The task may take as little as 5 minutes to administer and requires no pointing response. It takes advantage of the fact that young children are often well motivated to imitate speech sounds or can be trained to do so.

Of further interest is how performance on the Vowel Imitation task might predict future auditory comprehension ability. This paper aims to correlate performance on the Vowel Imitation task with two speech perception tests: Phonetically Balanced Kindergarten words (PBK words) and the Picture Vocabulary Subtest of the PLOTT. This paper aims to measure speech perception performance for young implanted children.
Vowel Imitation scores. A) Over time for 5 of youngest subjects. Scores represent post-cochlear implant performance. Children A and C were implanted at 2 years of age. Children B, D, and E were implanted at 3 years of age. B) Versus PBK words: phoneme score (N = 17). Scores represent percentage correct on each test. C) Versus PBK words: word score (N = 17). Scores represent percentage correct on each test. D) Versus Picture Vocabulary Subtest: scores for two lists of 12 monosyllabic words (N = 17). Scores represent percentage correct on each test.

significantly different (p < .05). The younger group demonstrated a higher mean than the older group. The group means for the last Vowel Imitation test were 68.9% for the young group and 41.8% for the older group. These were significantly different (p < .01). This result indicates that the young subjects obtained a higher group mean score than the older group. Taking into consideration the possible influences of language ability, phonetic repertoire, and the cognitive challenge of this task, the younger group did not appear to be more disadvantaged than the older group with the Vowel Imitation procedure. Both the young and the older groups demonstrated improvement on the Vowel Imitation task over time.

The Vowel Imitation results over time for the youngest 5 subjects are presented in the Figure, A.

Vowel Imitation Versus PBK Word Lists: Phoneme Score. For the 16 subjects who were able to complete formal speech perception testing, the scores from the Vowel Imitation task were compared with the phoneme scores from the PBK word lists. A Pearson product-moment correlation coefficient of .89 (p < .001) was obtained. The Figure, B, shows the scores for both tests. The results suggest that children who obtain a higher score on the Vowel Imitation task also obtain a higher score on an open-set word test.

Vowel Imitation Versus PBK Word Lists: Word Score. The scores from the Vowel Imitation task were compared with the word scores from the PBK word lists. A Pearson product-moment correlation coefficient of .74 (p < .001) was obtained. The Figure, C, shows the scores for these tests. These results suggest that a higher score on the Vowel Imitation task is associated with open-set word identification.

Vowel Imitation Versus Picture Vocabulary Subtest: 12 Monosyllabic Words. The scores from the Vowel Imitation task were compared with the percentage scores from the Picture Vocabulary subtest. A Pearson product-moment correlation coefficient of .85 (p < .001) was obtained. The Figure, D, shows the scores for these tests. These results suggest that a higher score on the Vowel Imitation task is associated with a higher score on the Picture Vocabulary closed-set test.
The Vowel Imitation task appears to be a useful tool for assessment of speech perception over time for young subjects with a cochlear implant. This has clinical relevance, as the youngest subject able to complete this test was a congenitally profoundly hearing-impaired child of age 2:11. Further investigation is required to follow these subjects over a longer period of time. Comparison of the Vowel Imitation performance of cochlear implanted children versus profoundly hearing-impaired children using hearing aids may also be of interest.

It is also important to note that once the child does demonstrate a "readiness" to perform formal testing, the Vowel Imitation task showed a highly significant correlation with the results from the PBK word lists, scored for phonemes and words, and the closed-set Picture Vocabulary test of 12 monosyllabic words. These correlations demonstrate the clinical utility of the Vowel Imitation task for the early assessment of speech perception performance. Early identification of poorer levels of performance may alert clinicians to the need to modify the child's speech processor program, to provide additional training, or to modify the educational or communication mode.

REFERENCES

POTENTIAL AND LIMITATIONS OF COCHLEAR IMPLANTS IN CHILDREN

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INTRODUCTION

Multiple-channel cochlear implants have been in use with children and adolescents for 8 years. The speech perception, speech production, and language of many of these children has been investigated in some detail.1-4 There have been many predictions about factors that may affect the performance of children with implants. For instance, it has been suggested that children with a congenital loss of hearing would not have the same potential to benefit from a cochlear implant as those with an acquired loss. Similarly, it has been suggested that younger children are likely to gain more benefit from a cochlear implant because of the effect of various critical ages for language learning.5 As more results have become available, it has been our observation that the performance of any particular child with a cochlear implant does not appear to follow well-defined rules, and that generalizations about the potential of certain groups of children are likely to encounter many exceptions. We now have a large quantity of results for children using cochlear implants, and it may be possible to determine some of the factors that have a significant effect on performance. This paper will attempt to identify some of these factors by reviewing speech perception results for 100 children implanted with the Nucleus 22-channel cochlear prosthesis in Australia and speech perception results for adult patients. This analysis will use an "information processing" model of a child using a cochlear implant. That is, we will assume that a child will benefit from a cochlear implant in terms of speech perception, production, and language development, if he or she receives a maximal amount of auditory information from the environment, and is able to process this information successfully. This model divides potential limiting or predictive factors into those that affect the information presented to the auditory system (eg, implant technology, surviving auditory neurons) and those that affect the processing of this information (eg, development of central auditory pathways, amount and consistency of auditory input).

METHOD AND RESULTS

The most recent speech perception results for all children and adolescents (up to 19 years of age) implanted in Melbourne and Sydney before January 1993 were tabulated, and each child was placed into one of seven hierarchic categories of speech perception performance. This resulted in a total of 100 children and adolescents in the study. This categorization of results provides a way of looking at the performance of children across age groups. It is not possible to use the same tests across all ages, but it is almost always possible to determine whether a child is consistently demonstrating a particular perceptual skill from available test results. In addition, the range of performance observed across children using cochlear implants is large, and no particular test can provide a useful measure of speech perception that covers this range. The categories used were arrived at after consultation with clinicians and were based in part on other categorizations used for speech perception results in children.6 The seven categories were as follows:

1. Detection of speech sounds only.
2. Discrimination of suprasegmental aspects of speech in addition to 1.
3. Discrimination and recognition of vowels in addition to 1 and 2.
4. Discrimination and recognition of consonants in addition to 1 through 3.
5. Minimal open-set speech perception in addition to 1.
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