

# SPEECH PERCEPTION IN CHILDREN USING THE ADVANCED SPEAK SPEECH-PROCESSING STRATEGY

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The Speak speech-processing strategy, developed by the University of Melbourne and commercialized by Cochlear Pty Limited for use in the new Spectra 22 speech processor, has been shown to provide improved speech perception for adults in both quiet and noisy situations. The present study evaluated the ability of children experienced in the use of the Multipeak (Mpeak) speech-processing strategy (implemented in the Nucleus Minisystem-22 cochlear implant) to adapt to and benefit from the advanced Speak speech-processing strategy (implemented in the Nucleus Spectra 22 speech processor). Twelve children were assessed using Mpeak and Speak over a period of 8 months. All of the children had over 1 year's previous experience with Mpeak, and all were able to score significantly on open-set word and sentence tests using the cochlear implant alone. Children were assessed with both live-voice and recorded speech materials, including Consonant-Nucleus-Consonant monosyllabic words and Speech Intelligibility Test sentences. Assessments were made in both quiet and in noise. Assessments were made at 3-week intervals to investigate the ability of the children to adapt to the new speech-processing strategy. For most of the children, a significant advantage was evident when using the Speak strategy as compared with Mpeak. For 4 of the children, there was no decrement in speech perception scores immediately following fitting with Speak. Eight of the children showed a small (10% to 20%) decrement in speech perception scores for between 3 and 6 weeks following the changeover to Speak. After 24 weeks' experience with Speak, 11 of the children had shown a steady increase in speech perception scores, with final Speak scores higher than for Mpeak. Only 1 child showed a significant decrement in speech perception with Speak, which did not recover to original Mpeak levels.

## INTRODUCTION

It has been established that use of multiple-channel intra-cochlear implants can significantly improve speech percep-

tion for postlingually deaf adults.<sup>1</sup> Since the original work leading to the development of the Nucleus 22-channel electrode in 1978, there has been a continuing improvement in

TEST SESSION SCORES (PERCENT) FOR TWELVE CHILDREN USING SPEAK SPEECH-PROCESSING STRATEGY AS COMPARED WITH MPEAK PROCESSING STRATEGY

Child	Mean Mpeak Test Score	Speak 1 Test Score	Speak 2 Test Score	Speak 3 Test Score	Speak 8 Test Score	Mean Speak Test Score
RW	52.4	56.3	57.6	56.0	64.4	62.5
SN	58.9	57.9	60.2	58.6	62.4	61.5
CTG	40.1	25.0	29.1	73.5	44.2	42.1
EB	23.1	22.5	22.3	22.0	27.0	28.5
MA	20.5	12.0	11.0	9.8	18.3	13.0
DH	44.3	57.2	55.6	57.6	67.2	65.1
SE	41.7	36.3	44.9	49.8	53.5	52.5
CP	83.1	61.0	85.5	84.0	91.4	88.7
AS	75.9	63.9	73.3	74.8	83.0	82.2
MV	52.9	43.8	62.9	67.9	71.2	73.3
MM	83.3	77.8	88.6	86.6	91.1	90.0
HMD	77.7	73.4	88.3	85.8	91.6	91.8

Scores for individual sessions were calculated from average of four test material scores (scores on CNC words and SIT sentences in quiet and in +15 dB signal-to-noise ratio on live-voice test materials). Mean Mpeak test scores were calculated by averaging all test session scores from four Mpeak evaluations (sessions Mpeak 1 through 4), and mean Speak test scores were calculated by averaging all test session scores from last four Speak evaluations (sessions Speak 5 through 8).

speech-processing strategies, providing additional benefits to speech perception for users.<sup>2</sup> This has recently culminated in the release of the Speak speech-processing strategy. This strategy, developed from research at the University of Melbourne,<sup>3</sup> employs 20 programmable band-pass filters that are scanned at an adaptive rate, with the largest outputs of these filters presented to up to 10 stimulation channels along the electrode array. To compare the Speak processing strategy, as implemented in the new Nucleus Spectra 22 speech processor, with the previously used Multipeak (Mpeak) speech-processing strategy, as implemented in the Minisystem-22 speech processor, evaluations with profoundly deaf adult cochlear implant users have been conducted at a large number of clinics worldwide. Results from this study have clearly 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.<sup>4</sup>

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. The children are a very diverse group, with a range of cause of deafness, age at onset of deafness, duration of profound deafness, hearing thresholds, history of hearing aid use, and communication and social skill development. In addition, whereas the large majority of adult implant patients are postlingually hearing-impaired, a significant proportion of children receiving the multichannel cochlear implant are congenitally deaf and have little or no knowledge of language. Despite this seeming disadvantage, results of speech perception testing in profoundly deaf children have shown benefits both to supplementation of lipreading and to development of receptive vocabulary from use of the implant. Results show that all children in the Melbourne program show some benefit from device use, and that 60% are achieving open-set perception of words and sentences using the cochlear implant alone.<sup>5</sup> These results have been recorded primarily for children using the Mpeak strategy implemented in the MSP speech processor. Although some children were originally fitted with the WSP III speech processor and used the F0F1F2 speech-pro-

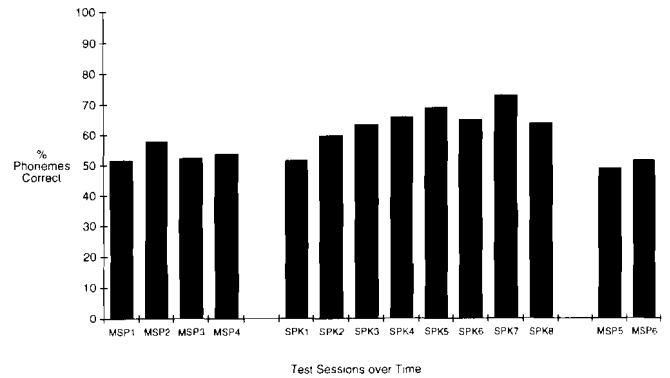
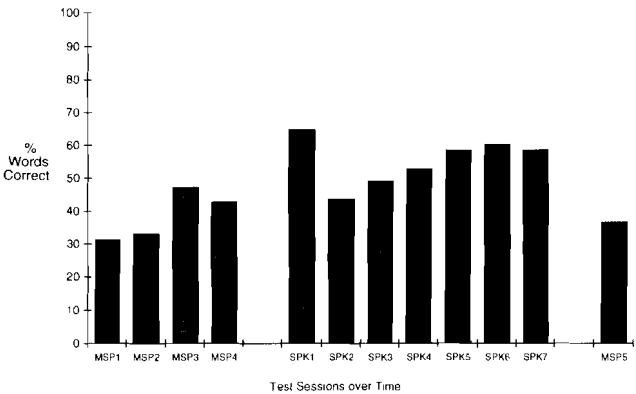
cessing strategy, all children were upgraded to the Mpeak strategy when it became available. It was noted at the time of changeover that a significant number of children required a period of from 1 to 6 months to adapt to the new Mpeak processing strategy. For this reason, there was a perceived need to examine in detail the ability of children to change from the Mpeak to the Speak speech-processing strategy, to provide information that could be used to counsel parents as to expectations in the immediate post-change period. In addition, given 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.

#### AIMS

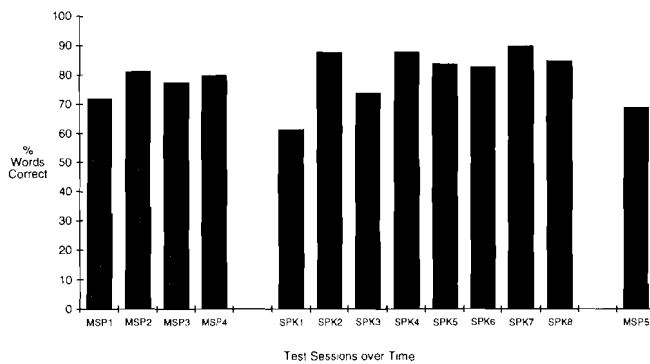
The study was primarily aimed at evaluating whether children who were experienced in use of the Mpeak speech-processing strategy would be able to change over to the new Speak processing strategy, which provides a subjectively different output. Second, the study aimed to evaluate the benefits that might accrue to children from use of the Speak processing strategy, particularly in the presence of background noise. Results presented in this paper will focus on the evaluations of changeover. Detailed analysis of the comparative benefits from use of the two speech-processing strategies will be presented elsewhere.

#### METHODS

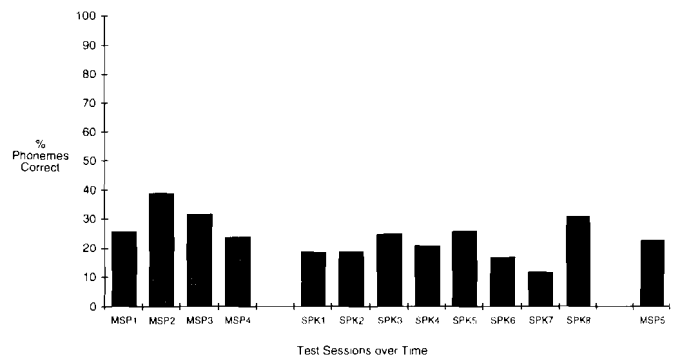
Twelve children participated in the study. These children were all patients of the University of Melbourne/Royal Victorian Eye and Ear Hospital Cochlear Implant Clinic (7 children) or Children's Cochlear Implant Clinic of the Royal Alexandra Hospital for Children in Sydney (5 children). All of the children had more than 1 year of experience with the Mpeak 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 to 14 years. No other specific selection criteria were applied, and the children varied in cause of deafness, length of profound deafness



A



B



C

Implant-alone scores for children using Mpeak and Speak processing strategies in quiet. A) SIT sentences, child DII. B) CNC words, child SE. C) CNC words, child CP. D) CNC words, child MA.

D

preimplant, residual hearing thresholds, age at onset, and experience with the device. These children represented a reasonable cross section of the pediatric population in both clinics.

The children were evaluated with open-set Consonant-Nucleus-Consonant (CNC) monosyllabic words and open-set Speech Intelligibility Test (SIT) sentences. The CNC words were scored by phonemes correct. The SIT sentences were 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 independently scored by two experienced clinicians. Each list was only used once for each child, and the use of lists and order of presentation was balanced between processors and across sessions. Each child also had one test with both the Mpeak and Speak processing strategies using prerecorded test materials in a sound-treated room.

In each test session children were assessed with both materials in quiet and in the presence of background noise. Following initial pilot studies, a signal-to-noise ratio of +15 dB sound pressure level was chosen for all test sessions. The noise used was prerecorded multitalker babble, which was presented through a Marantz portable tape player. The levels of noise (55 dB A-weighted sound pressure level) and of the test signal (70 dB A-weighted sound pressure level) were continuously monitored by a sound level meter located at the position of the child's input microphone.

The test was an ABA design. Four initial evaluations with Mpeak were conducted at 2-weekly intervals. Children were then switched to Speak, and were subsequently evaluated at 3-weekly intervals over a 6-month period (eight evaluations). The children were then changed back to Mpeak, and one evaluation session using live-voice materials was completed with Mpeak.

To analyze specific changes over time, the scores on both CNC words and SIT sentences in both quiet and background noise conditions were collapsed to give a "test session score" (ie, the four different scores for each child were averaged for each evaluation session). To assist data presentation, mean scores for the four Mpeak evaluations were combined to give a pre-change figure for each child. Collapsed "test session scores" for each child were calculated for Speak evaluations 1, 2, and 3, which occurred at 3 weeks, 6 weeks, and 9 weeks following changeover. Test session scores for Speak evaluation 8 (24 weeks post-change) and a mean Speak test session score (calculated from averaging the last four Speak evaluation scores from sessions 5 through 8) were also calculated.

## RESULTS

The Table shows test session scores for the 12 children at the intervals mentioned above. As shown, at Speak session 1, 2 children showed improved scores with Speak as compared with mean Mpeak test session scores, 2 children had similar test session scores in both strategies, and the remaining 8 children showed decreased test session scores with Speak. At

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 at Speak session 1, followed by an increase in Speak scores through to Speak 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 FOF1F2 to Mpeak, and a

period of approximately 12 months was required before scores with Mpeak equaled those with FOF1F2.

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.

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