The Effect of Language Knowledge on Speech Perception: What Are We Really Assessing?

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Objective: The authors examined whether open-set speech perception scores are limited by knowledge of vocabulary and syntax and further considered whether remediation of vocabulary and syntax will increase open-set speech perception scores.

Study Design: This was a repeated-measures study design in the setting of a primary (elementary) school for the hearing-impaired.

Patients: The study population was composed of three hearing-impaired children using Nucleus 22-channel cochlear implant.

Intervention: Intervention used was language remediation sessions.

Main Outcome Measures: The main outcome measures were assessment of auditory-alone speech perception benefit using open-set words and sentences and assessment of syntactic knowledge using the Test of Syntactic Ability. Outcome measures were applied before and after remediation.

Results: Child 1 and child 2 showed a significant postremediation improvement in their overall scores on the Test of Syntactic Ability and in their ability to perceive words learned during remediation. Child 1 and child 2 also showed a significant improvement in their scores on a modified Bamford–Kowal–Bench open-set sentence test, which specifically targeted grammatical constructs trained in remediation sessions.

Conclusions: Remediation of language knowledge deficits significantly improved open-set speech perception for two children, suggesting a need to include language remediation in cochlear implant habilitation programs. Key Words: Cochlear implant—Language knowledge—Speech perception.


Previous research has shown that speech perception abilities of children with cochlear implants vary across a wide range (1–5). It is therefore important to determine the factors that influence speech perception and how they interact so that we can maximize the potential of each child to perceive speech and to develop a competent grasp of language through their audition. It also has been clearly shown that there is a significant gap in terms of language acquisition between most children with a severe or profound hearing impairment and their normally hearing peers (6,7). It has been shown that hearing-impaired children have a slower rate of language acquisition and that their overall mastery of the pragmatics, syntax, and vocabulary of language is significantly poorer (8,9).

As speech perception tests are based on language, it would seem logical that deficits in vocabulary or syntactic knowledge may limit children's abilities to use the phonemic information provided to them through their cochlear implant in a meaningful manner for communication. Furthermore, remediation of such deficits should improve children's abilities to use the information provided through their implant and result in improved speech perception scores on open-set tests. Therefore, we may in fact be underestimating the potential speech perception abilities of at least some hearing-impaired children. This study examined the effects of remediation of syntactic knowledge and vocabulary on open-set speech perception for three children. Two hypotheses were tested: 1) Open-set speech perception scores are limited by knowledge of vocabulary and syntax; and 2) remediation of vocabulary and syntax will increase open-set speech perception scores.

SUBJECTS AND METHODS

Evaluations

A test battery to assess speech perception and language was administered before and after training. Test materials were presented live-voice, by a familiar female speaker, at a distance of 1 m and at an intensity of 70 dB. Children wrote their responses for all tests, and no repeats were given. Feedback on performance was not provided throughout test procedures. All speech perception testing was conducted in the implant alone condition (A). The test battery comprised the following.

Supported by the National Health and Medical Research Council of Australia.

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Test of Syntactic Abilities

The Test of Syntactic Abilities (TSA) was used to assess syntactic knowledge before and after remediation. Items from the TSA (10) were selected and added to construct a 10-minute written test covering present, past, progressive, and past tenses, determiners, and plurality. Each item was a multiple-choice task, and there were 10 items per grammatical construct, for a total of 50 items.

Monosyllabic Arthur Boothroyd words

Arthur Boothroyd (AB) words were used to test perception of known and unknown vocabulary. The speech perception of each child was tested with AB words (11) at the start of the study using the complete set of 15 lists. Children were asked to give a definition of all the words on the lists. Word and phoneme scores were calculated for each child for both known and unknown words. Comparing these scores gave an indication of whether knowing a word had a significant effect on how well it was perceived. The children then were taught the meanings of all the words they did not know, after which speech perception again was assessed on all lists.

Amended Bamford-Kowal-Bench sentences

The Bamford-Kowal-Bench (BKB) sentence test (12) provided a basis for individually assessing specific grammatical constructs and evaluating whether perception of these improved after the children had been taught the rules governing their use. The sentences were standardized so that each list contained approximately equal numbers of each grammatical construct, all of which were scored as key words. Each child was evaluated with five lists before and after training. A total score across five lists was calculated for each grammatical construct.

Subjects

Three children participated in this study. At the time of the study, child 1 and child 2 were 9 years of age, and child 3 was 15 years of age. All children had been implanted at least 21 months. Child 1 and child 2 were implanted younger than 10 years of age, whereas child 3 was implanted as an adolescent.

Remediation

Greatest areas of need for each child were identified by their scores on the TSA and by analysis of speech perception scores for grammatical constructs on BKB sentences. Child 1 received remediation on simple present tense, whereas child 2 and child 3 received remediation on the past tense. Each child was seen twice-weekly for 30 minutes over a period of 12 weeks. Games, conversational activities, written activities, and role-playing were used to facilitate learning.

RESULTS AND DISCUSSION

On the TSA, child 1 and child 2 showed significant improvements (p < 0.05) in post-training scores overall, whereas child 3 showed no improvement. This shows that the remediation was effective in addressing the targeted language deficits for child 1 and child 2. On AB words, initial scores for unknown words were significantly lower than known words for child 1 and child 2, who did not know 37% and 58% of the word meanings, respectively. After the vocabulary was learned, scores for unknown words increased significantly (p < 0.001; p < 0.01, respectively), whereas scores for known words remained the same. The fact that scores for known words did not improve significantly whereas those for unknown words did suggests that remediation of language deficits and not further practice in using their audition affected the children's abilities to use the information provided by the implant. Child 3 knew more words than did the other children; only 31% of the words were unknown. Speech perception scores for child 3 did not improve significantly pretraining to post-training. Figure 1 shows the mean scores for three children on the AB word test.

On BKB sentences, there were significant differences overall between pretraining and post-training scores for child 1 and child 2 (p < 0.005). Child 2 also showed a significantly greater improvement for trained versus untrained grammatical constructs (p < 0.01). Scores for child 3 were much lower overall than for the other children and, surprisingly, post-training scores for untrained constructs decreased significantly (p < 0.05). However, child 3 had both better vocabulary knowledge and language (syntactic) skills than both of the other children and poorer speech perception abilities. Therefore, it seems likely that language was not the limiting factor for child 3, and, thus, remediation language did not improve her speech perception scores significantly.

CONCLUSION

Deficits in language knowledge significantly affected the open-set speech perception scores of two children in this study. Remediation of these deficits significantly improved open-set speech perception. These results suggest a need to include language remediation in cochlear implant habilitation programs. This also raises a question of whether reported results may accurately predict the potential speech perception abilities of children with language deficits.
Acknowledgment: The authors thank the children and parents who participated in this study and the staff at St. Mary’s School for Children with Impaired Hearing.

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Sarant, Julia Z.; Blamey, Peter J.; Cowan, Robert S.; Clark, Graeme M.

Title:
The effect of language knowledge on speech perception: what are we really assessing?

Date:
1997

Citation:

Persistent Link:
http://hdl.handle.net/11343/27565

File Description:
The effect of language knowledge on speech perception: what are we really assessing?

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