THE EFFECT OF LANGUAGE KNOWLEDGE ON SPEECH PERCEPTION IN CHILDREN WITH IMPAIRED HEARING

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ABSTRACT - Open-set words and sentences were used to assess auditory speech perception of three hearing-impaired children aged 9 to 15 years using the Nucleus 22-channel cochlear implant. Vocabulary and syntax used in the tests were assessed following the initial perception tests. Remediation was given in specific vocabulary and syntactic areas, chosen separately for each child, and the children were reassessed. Two children showed a significant post-remediation improvement in their overall scores on the syntactic test and both perception measures. The third child who was older, had the best language knowledge and the lowest auditory speech perception scores, showed no significant change on any of the measures. Language remediation in specific areas of weakness may be the quickest way to enhance speech perception for some children with impaired hearing in this age range.

INTRODUCTION

Previous research has shown that speech perception abilities of children with cochlear implants vary across a wide range (Cowan et al., 1995; Dowell et al., 1992; Miyamoto et al., 1993; Osberger et al., 1991; Staller et al., 1991). It is therefore important to determine the factors that influence speech perception, and how they interact, so that we can maximise the potential of each child to perceive speech and to develop a competent grasp of language through their audition. It has also been clearly shown that there is a significant gap in language acquisition between most children with a severe or profound hearing impairment and their normally-hearing peers (Kretschmer & Kretschmer, 1986; Paul & Quigley, 1994). Hearing-impaired children have a slower rate of language acquisition, and their overall mastery of the pragmatics, syntax and vocabulary of language is significantly poorer (Geers & Moog, 1995; Moores, 1987). A recent report on the vocabulary of 32 children using a multichannel cochlear implant indicated that the mean rate of vocabulary acquisition post-implantation was equal to the rate for normal children, although the mean rate prior to implantation was less than half the normal rate (Dawson et al, 1995a). In spite of this encouraging result, many of the individual children were still falling behind their normally-hearing peers in word-knowledge and other aspects of language. As speech perception tests are based on language, it would seem logical that deficits in vocabulary or syntactical 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. That open-set speech perception scores are limited by knowledge of vocabulary and syntax.
2. That remediation of vocabulary and syntax will increase open-set speech perception scores.

METHOD

Evaluations
Speech perception and language tests were administered before and after training. Speech perception test materials were presented with live-voice, by a familiar female speaker, at a distance of 1 metre, and at an intensity of 70 dBA. Children wrote their responses for all tests, and no repeats were given. Written responses were required to avoid the problem of subjective interpretation of the children's spoken responses. Profoundly hearing-impaired children commonly have poorly articulated and partially unintelligible speech (Markides, 1979; McGarr & Osberger, 1982). Although the speech of children using cochlear implants has been shown to improve over time, not all children reach a high level of intelligibility (Dawson et al, 1995b; Grogan et al, 1995). 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:

Test of Syntactic Abilities

The Test of Syntactic Abilities (Quigley et al., 1978) was used to assess syntactical knowledge before and after remediation. Items from the TSA were selected and added to in order to construct a 10-minute written test covering present, present progressive and past tenses, determiners and plurality. Each item was a four-alternative multiple-choice task, and there were 10 items per grammatical construct, making a total of 50 items. The questions were administered using a printed form and answers were written.

Monosyllabic AB Words

Arthur Boothroyd Words (Boothroyd, 1968) were used to test perception of known and unknown vocabulary. The speech perception of each child was tested with AB Words at the start of the study using the complete set of 150 words in fifteen lists. Children were then 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 were then taught the meanings of all the words they did not know, after which speech perception was again assessed on all lists.

Amended Bamford-Kowal-Bench Sentences

The BKB Sentence Test (Bench et al., 1979) 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 sentence lists were standardised 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 sentence lists prior to 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 aged nine, and Child 3 was aged 15 years. Child 1 and Child 2 were implanted under the age of 10, whereas Child 3 was implanted as an adolescent. All three children had a profound hearing loss with no measurable hearing thresholds at 2000 Hz or above and hearing thresholds in excess of 95 dB at 500 Hz and 110 dB at 1000 Hz. All three children consistently wore hearing aids from the time of diagnosis of deafness until the time of implantation. They all communicated orally, although Child 2 also used manual communication and only Child 1 had speech that was intelligible to an inexperienced listener.

Remediation

Areas of greatest need for each child were identified by their scores on the TSA, and by analysis of errors for grammatical constructs in the BKB Sentence Test. Child 1 received remediation on simple present tense, while Child 2 and Child 3 received remediation on the past tense. Each child was seen twice-weekly for 30 mins over a period of 12 weeks. The unknown vocabulary from the AB Word Test was explained by the audiologist and used in meaningful contexts by the children. Games, conversational activities, written activities and role-playing were used to facilitate learning.

Remediation was specifically concerned with improvement of vocabulary and language knowledge, and the use of audition was not emphasised in any way.

<table>
<thead>
<tr>
<th>Child</th>
<th>Aetiology</th>
<th>Age at Onset of Profound Deafness</th>
<th>Duration of Profound Deafness</th>
<th>Age at Implantation</th>
<th>Duration of Implant Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>2y</td>
<td>1y8m</td>
<td>3y8m</td>
<td>5y11m</td>
</tr>
<tr>
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<td>0y</td>
<td>8y2m</td>
<td>8y2m</td>
<td>1y9m</td>
</tr>
<tr>
<td>3</td>
<td>congenital rubella</td>
<td>0y</td>
<td>12y</td>
<td>12y</td>
<td>4y</td>
</tr>
</tbody>
</table>

Table 1. History of deafness for each subject in the study.

RESULTS AND DISCUSSION

Figure 1. Mean scores for three children on the AB Word Test. Phoneme scores are shown on the left, and word scores on the right. The 'unknown' description refers to words whose meanings were unknown prior to remediation, but known after remediation.

On AB words, initial scores for unknown words were significantly lower than known words for Child 1 and Child 2. They did not know 37% and 42% of the meanings of words respectively. After the vocabulary was learned, scores for unknown words increased significantly (p<0.001; p<0.01 on a chi-squared test for Child 1 and Child 2 respectively), while scores for known words remained the same. Child 3 knew more words than the other children (31% were unknown before remediation). Speech perception scores for Child 3 did not improve significantly pre to post-training. Chi-squared analysis of the mean data shown in Figure 1 indicated that post-remediation scores were significantly higher than the improvement for known words (p<0.001 for each comparison, using separate analyses for word and phoneme scores). The fact that scores for known words did not improve significantly while those for unknown words did suggests that remediation of language deficits and not further practice in using the audition affected the children's abilities to use the information provided by the implant.

On the TSA, Child 1 and Child 2 showed significant improvements (p<0.05) in post-training scores overall, while Child 3 showed no improvement. This indicates that the remediation was effective in addressing the targeted language deficits for Child 1 and Child 2. The training concentrated on simple present tense for Child 1 and simple past tense for Child 2 and Child 3. Determiners and plurality were
not trained. The results in Figure 2 suggest that the trained tense items improved more than untrained items in the written (multiple-choice) TSA, although there was no statistically significant difference in the improvements observed for tense and other items.

On BKB sentences there were significant differences between pre- 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 grammar constructs (p<0.05). 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, it should be noted that Child 3 had better language than Child 1 and Child 2, and poorer speech perception abilities. It seems likely that language was not the limiting factor for Child 3 and thus remediating language did not improve her speech perception scores significantly. The mean scores shown in Figure 3 indicate that the training in grammatical constructs improved perception of key words in sentences which used those constructs that were specifically trained. The improvement for items involving tense was significantly greater than the improvement for other items not involving verb tenses (p<.05).

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 programmes. This also raises a question as to whether reported results may accurately predict the potential speech perception abilities of children with limited language.

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REFERENCES


ANGRY, HAPPY, SAD OR PLAIN NEUTRAL?
THE IDENTIFICATION OF VOCAL AFFECT
BY HEARING-AID USERS

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ABSTRACT - This paper reports a speech perception study on the identification of vocal affect by hearing aid users. The performance of a group of 40 normally-hearing subjects is compared to that of a group of 39 post-lingually deafened subjects using hearing-aids. All subjects are adult native speakers of English. Results indicate that there are major differences between the two groups. Scores for overall identification of affect are 85% for the normally hearing listeners and 65% for the hearing-aid users. Patterns of confusion in the identification of emotions are similar in the two groups, but there is a greater degree of confusion in the hearing-aid users. There is a significant negative correlation between hearing-loss and the correct identification scores.

INTRODUCTION

In social interactions, understanding the mood and attitude of a speaker is very important for understanding the meaning of a spoken message. Mood and attitude can be communicated verbally but more often than not they are communicated non-verbally through body language, facial expression and voice. This emotional meaning expressed non-verbally may reinforce the verbal message, add to it or contradict it. For the hearing-impaired, who have difficulties in understanding the verbal content of a spoken message, the perception of the emotion and attitude as expressed by the tone of voice is even more important socially than for normally hearing people, especially if visual cues are not available. For the hearing-impaired the issue is not just a question of "It ain't what you say, but the way you say it", but "It ain't what you say, but the way I hear it".

Few published studies exist to date which examine the perception of vocal affect by the hearing impaired. Anne-Marie Öster and Arne Risberg (1986) showed that hearing-impaired children and adults fitted with hearing-aids had difficulty in identifying the mood of a speaker in test sentences, particularly confusing happy, angry and sad. In his research, David House (1989, 1990a, b, 1991) replicated these findings. He also found that the conclusions formed two main patterns: happiness was confused with anger, and sadness was confused with neutrality. House (1991) working on a sample of 29 listeners with moderate to severe hearing losses found that performance did not correspond to the degree of hearing loss, which seems surprising, but is nevertheless corroborated by the findings of Most et al (1993) who worked on a sample of 24 severe to profound listeners. However, Most et al suggest that with a group including subjects with better residual hearing, it would be more likely that one could observe correlations between loss and correct identification of emotion.

This study addresses the question as to whether adults with normal hearing and those who are post-lingually deafened and are using hearing-aids perceive equally well the expression of mood in the speech of others.

METHOD

Subjects

All subjects were adult native speakers of English.

The hearing-aid users: The experimental group consisted of 39 post-lingually deafened subjects with total to severe degrees of sensorineural hearing loss in one or both ears. The mean age for this group was 68 years, with a range of 46 to 83 years and a standard deviation of 9 years. There were 15 women and 24 men. The mean 3 frequency average loss for their better ear was 39 dBHL, with a range from...
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