Published in final edited form as:

Adv Otorhinolaryngol. 2000 ; 57: 300–304.

Language and Reading Acquisition in Children with and without Cochlear Implants

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The past 20 years has seen a substantial improvement in our understanding of the relationship between spoken language development and reading development. Numerous studies have shown that the spoken language skills of children entering school are important predictors of later reading success [1–4].

Some of the most convincing evidence of the close association between spoken language and reading comes from studies of reading development in children who are deaf. Furth [5] has reported that deaf children often fail to reach the fifth grade reading level by the time they graduate from school. These findings were in accord with others [6, 7] who have shown that children who are deaf gain on average 0.20 and 0.33 grade levels of reading for each year in school. More recently studies also demonstrated similar slow reading achievement levels [8].

Children who have received cochlear implants provide an interesting population for the study of the relationship between spoken language and reading. Recent research has begun to show that children receiving cochlear implants make substantial gains in spoken language [8]. If reading is strongly linked to spoken language development, we should expect to see gains in reading scores.

Methods

Participants for the language testing included 17 children who had prelingual, profound bilateral deafness who received the Nucleus 22-channel cochlear implant between 31 and 120 months of age. The average age at time of testing was 12.8 years (range 8.5–18.4 years), and the average length of implant experience was 85 months (range 36–132 months).

Participants for the reading study consisted of 30 children with prelingual, profound bilateral deafness who received the Nucleus 22-channel cochlear implant between the ages of 31 and 168 months.

The language measure included three subtests of the Clinical Evaluation of Language Fundamentals [9]. The reading measure was the paragraph comprehension subtest of the Woodcock Reading Mastery Test-Revised Form G [10].

Results

Figure 1 displays results from the Concepts and Directions subtest, a receptive language measure employing sentences of different degrees of complexity, the Formulated Sentences

and Sentence Assembly subtests, which are expressive language measures. Figure 1a shows that the average percentile scores for these children approached or slightly exceeded the average (50 percentile) for hearing children of their age for the Concepts and Directions test and the Sentence Assembly test. Lower average scores were found on the Formulated Sentences test. This test requires the production of complex sentences which is challenging for these children. Figure 1b shows the percentile scores for each child for each subtest as a function of their chronological age. This analysis shows that on each test, the percentile scores are systematically higher for the older children than the younger children. Percentile scores are based on the child's standing among age-mates, thus we would not expect to see systemic increases unless the older children were catching up with their hearing age-mates. An examination of the regression lines reveals that by the time these children reach adulthood they seem to be attaining normal levels of language achievement.

These data demonstrate that cochlear implantation provides a sufficient auditory experience to permit many children to obtain language skills that clearly exceed the levels obtained by nonimplanted deaf children and approach the levels of most normally hearing children. The spoken language gains in this population would lead us to expect to find concurrent gains in reading levels. Most of the children who participated in the spoken language studies also participated in the reading study. All children have been examined twice with respect to reading. This allowed for examination of gains across children and within children. The measure of reading achievement used was the paragraph comprehension subtest of the Woodcock Reading Mastery Test. This test asks the child to read a passage and then finish a sentence that depends upon the information provided in the paragraph.

Figure 2 illustrates gains made in reading. The children in this study had an average age of 11 years for the first exam and 12 years for the second exam. At the first examination, average grade level was mid fifth grade, and average reading comprehension level was mid third grade. At the second exam average grade level was mid sixth grade, and average reading level had improved by two grade levels. Thus, the reading levels of these children were approaching those of their hearing chronological age-mates.

Figure 3 illustrates an accelerating growth in reading when the data are plotted with regard to percentile ranks. In this figure the reading scores are represented in terms of percentile ranks for each child based on their grade level. Note that the children in the early grades tend to have lower scores than those in the higher grades. The regression line shows that by the end of high school the children with cochlear implant experience are reaching average to above average reading levels, whereas the children in the early grades are well below average.

Summary and Conclusions

These data provide a coherent view of the spoken language and reading skills of children receiving cochlear implants. The data reveal both spoken language gains and clear benefit to these children with regard to reading. Improvement in reading is consistent with predictions based on prior research demonstrating a strong association between spoken language and reading. An intervention such as a cochlear implant has a direct effect on spoken language, and this can subsequently affect reading performance. This provides some of the first experimental evidence supporting the causal relationship between spoken language and reading.

Acknowledgments

This study was supported in part by a research grant awarded to the Department of Otolaryngology, Head and Neck Surgery, University of Iowa (number 2)50 DC 00242, from the National Institute of Deafness and Other

Communication Disorders, National Institutes of Health, grant RR00059 from the General Clinical Research Center, Division of Research Resources, NIH, the Lions Clubs International Foundation, and the Iowa Lions Foundation.

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Fig. 1. Language test results from three subtests of the CELF battery, **a** Average percentile scores for the group of children with cochlear experience, **b** Percentile scores as a function of age and regression lines for each subtest.

Fig. 2.

Age, grade and reading levels between test scores at year 1 and year 2. Note that more than 1 year gain is made in 1 year time frame.

Fig. 3. Association between amount of education and percentile in reading achievement. Children in early grades have lower scores than children in higher grades.