

Critical Review:

Do cochlear implants improve literacy outcomes in children with hearing impairments?

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This critical review examines the impact that cochlear implants have on literacy outcomes in children with hearing impairments as compared to children with normal hearing. Study designs include: non-experimental, descriptive, exploratory studies. Overall, current research provides insufficient evidence as to whether cochlear implants improve literacy outcomes in children with hearing impairments. Further research needs to be conducted to obtain more detailed and consistent results. This research will assist in providing appropriate intervention for these children to ensure their overall academic, vocational and social success.

Introduction

Children with hearing impairments are at risk for serious difficulties acquiring and developing literacy skills. Among children with severe to profound hearing impairment, low literacy rates have frequently been reported in the literature. Numerous studies with children who are deaf show that literacy development and proficiency has been challenging for this population (Spencer et al., 2003).

Literacy difficulties can impact the child's academic, social and emotional success. The relationship between cochlear implants and literacy outcomes is important to understand and examine so that appropriate and adequate information can be provided to parents, educators and professionals.

When hearing children learn to read, most are competent language users and map their existing phonological, syntactic, semantic and discourse skills onto the newly acquired task of reading. The deaf child approaches the reading task with an incomplete spoken language system and, because reading is a speech based system, this significantly increases the difficulty of the task (Geers, 2003). Generally, the use of a cochlear implant provides access to a greater range of speech sounds than would have been provided through traditional amplification for the child with the implant (i.e., hearing aids). As a result, this may facilitate and improve development of speech perception skills in children with hearing impairment (Watson, 2002).

In children with normal hearing, language skills and literacy are highly interdependent and progressively develop throughout the elementary school years (Watson, 2002). During the initial stages of reading (from birth to six or seven years of age), the child develops the knowledge that words are made up of individual sounds and there is a relationship between each letter and its' sounds

(Spencer et al., 2003). During the later stages of reading (from seven years of age to approximately fourteen years of age), the literacy demands increase. Children are expected to develop both "top down" (i.e., meaning to print) and "bottom up" (i.e., print to meaning) processing skills to aid in comprehension (Spencer et al., 2003). It is hypothesized that cochlear implants provide the child with the ability to utilize phonological ("bottom up") strategies therefore allowing them to decode unfamiliar words.

The link between speech perception, speech production and language development is a strong one, leading to the hypothesis that cochlear implants will improve the language and literacy skills in deaf children.

Research that has examined the language and literacy skills in children with cochlear implants has primarily focused on children who received their implant prior to the age of five years and participated in the mainstream education system.

Objectives

The primary objective of this paper is to critically evaluate existing literature regarding the impact of cochlear implants on the literacy skills of children with hearing impairments and compare these results to children with normal hearing. The secondary objective is to propose evidence-based practice recommendations for future research that would hold clinical significance.

Methods

Search Strategy

Computerized databases, including CINAHL, PubMed, and MEDLINE, were searched. The following key terms and search strategies were used:

(Cochlear Implants) AND (children) AND ((literacy) OR (reading) OR (writing)) AND ((skills) OR (outcomes)).

The search was limited to articles written in English between 1995 and 2005.

Selection Criteria

Studies selected for inclusion in this critical review paper were required to investigate the literacy skills and outcomes in children with cochlear implants, as compared to children with normal hearing. No limits were set on the demographics of research participants or outcome measures.

Data Collection

The literature identified three studies that met the above selection criteria. These consisted of studies employing observational designs, specifically, studies that can be classified as non-experimental or descriptive.

Results

A study conducted by Watson (2002) investigated the literacy performance on a standardized assessment tool, for ten, seven year old students, all implanted prior to their fifth birthday. All children were educated within the mainstream educational system in the UK (Watson, 2002). The following skills were examined: reading (requiring students to independently read a chosen passage aloud); reading comprehension (after reading a short story, students provided written responses to questions about the story); writing (independent writing piece was analyzed based on a specific task from a book) and spelling (consisted of two parts; child filling in blank spaces on a page, labelling pictures and child filling in 'missing words' while reading along with teacher's dictations). The examiners also reviewed teacher observations and samples of the student's work, to look for any phonological strategies that the children may have been using while reading, suggesting that they were able to access the speech sounds provided to them by the implant.

Watson (2002) found that seven out of the ten students in the study achieved the 'expected level' for their age group, meaning they are approaching the level of their hearing peers, for reading and writing in their standard assessments. In the cohort of deaf children, seven out of ten children achieved the expected level for their age in reading, three out of ten in spelling and six out of ten in writing. Information on strategies that the children were observed to use was provided by the teachers for five of the. The information indicated that most students

were using phonological strategies, however no examples were provided. In addition, it was observed that some students relied on visual and contextual cues when experiencing difficulty reading. It was suggested that these strategies and skills can be further developed in these children through explicit teaching.

The main focus of a study by Spencer, Barker and Tomblin (2003) was to assess the relationship between language and literacy skills in 16 prelingually deafened children with cochlear implants who used simultaneous communication (sign language and speech) in the classroom.

Various subtests from standardized assessment tools (norms provided for hearing children) were administered to the children with cochlear implants, according to guidelines. All testing was completed in both speech and signed English, so children could choose their preferred response, resulting in a representative view of their best performance. The results from the cochlear implant group were compared to results from a group of 16 age-matched children with normal hearing.

To assess receptive and expressive language skills the "Formulated Sentences" and "Concepts and Directions" subtests of the *Clinical Evaluation of Language Fundamentals-III (CELF-3)* was used. For the expressive subtest, "Formulated Sentences," the cochlear implant group scored 1.6 SD below the mean of the normal hearing group. For the receptive subtest, "Concepts and Following Directions" the performance of the cochlear implant group was 0.69 SD below the mean of the normal hearing group.

To measure reading comprehension the "Passage Comprehension Test from the *Woodcock Reading Mastery Tests Revised Form (WRMT)* was administered. The normal hearing group obtained a mean score of 99.5 (SD=14.09), thus representing a group of average readers for their age and grade level. The cochlear implant group obtained a mean score of 90.13 (SD=11.18). A t-test was conducted and revealed a significant difference between the mean standard score for both groups ($t(3)=-2.09, p < 0.05$). In terms of grade equivalency, the average reading grade levels for the hearing group and cochlear implant group were 3.8 and 3.3 respectively.

To assess writing, the children were asked to write about a chosen picture series. Results indicated that the cochlear implant group used shorter, less complex sentences. In addition, they had significantly fewer instances of the following grammatical categories; pronouns, verbs, determiners, adverbs, conjunctions and prepositions (Spencer et al., 2003).

Overall, Spencer et al. (2003) found that reading comprehension, language comprehension and writing scores for the cochlear implant group fell within the

lower end of average (within one standard deviation). There was a stronger association between language and reading skills for the cochlear implant group. The cochlear implant group was found to have a strong significant correlation ($r=0.8$) between language and reading, while the normal hearing group was found to have a moderate correlation ($r=0.52$).

Geers (2003) examined the results of three subtests from diagnostic reading assessment batteries conducted on children with cochlear implants (standardized on children with normal hearing). The subjects were also administered a battery of processing measures, which included a rhyme task, a lexical decision task, and the digit span subtest of the Wechsler Intelligence Scale for Children.

The study consisted of 181 subjects, 8-9 years of age, all with 4-6 years of implant experience. The tasks were designed to target specific isolated language skills (i.e., the use of phonological strategies through a lexical decision task).

All of the statistical analyses used recognized the interrelatedness of the language areas that contribute to literacy. For the reading measures, an intercorrelation matrix was used to summarize the similarities between all reading measures analyzed. To analyze processing and memory errors, a t-test was conducted and subsequently an ANOVA comparing error rates in certain categories. In addition, correlation coefficients were calculated to compare performances within language areas (i.e., reading outcome measures and processing/memory measures). The author also accounted for the effects of extraneous variables (i.e., child and family characteristics) on literacy skills. These characteristics were entered into a multiple linear regression analysis to determine which ones had the greatest effect on literacy.

Results indicated that over half of the children in the cochlear implant group scored within the average range for their age, when compared with hearing children. Factors such as higher nonverbal intelligence, higher socio-economic status, female gender and onset of deafness (later as opposed to earlier) were all associated with reading competence. Speech processing characteristics such as the use of phonological strategies and increased working memory span also contributed to more successful reading outcomes.

The variable most associated with reading outcome was overall language competence (a variable which includes measures of comprehension, production, verbal reasoning and use of the narrative form). This suggests that the auditory speech perception skills provided by the implant are not sufficient enough to promote literacy skills, rather the

child must have adequate language competence to achieve reading proficiency (Geers, 2003).

Due to the heterogeneity of the population being studied, non-experimental or descriptive designs were appropriately used. In addition, the standardized assessment measures chosen for each study assessed a variety of language domains. Geers (2003) conducted the most comprehensive assessment of the areas that contribute to language development and in turn, literacy, such as memory and processing abilities. Her study also took multiple measures of each language area, to accurately represent the child's language abilities in each area.

A potential weakness in the study conducted by Watson (2002) is that, in the assessment of reading comprehension, the children were required to provide written responses. Difficulties that the children may have had with writing may have affected their scores on the reading comprehension task. It would have been more representative to have the children provide verbal responses to measure their comprehension.

One study (Spencer et al., 2003) analyzed the types of errors that the children in the cochlear implant group made, in particular, errors on the written tasks. By examining errors, consistencies and patterns can be identified and the results can be applied clinically (i.e., intervention can work to reduce those errors).

Only one of the studies examined, (Watson, 2002) provided detailed information on subject selection. Since all subjects had similar educational backgrounds, differences in results could not be attributed to differences in educational systems. Although the remaining two studies (Spencer et al., 2003; Geers, 2003) did not provide detailed information on subject selection some important pieces of background information on the subjects were provided. Spencer et al., (2003) reported gender, educational placement, the child's preferred form of communication (sign or speech), average age of implantation and average length of experience with the implant. Geers (2003) indicated the type of school attended, communication mode and amount of parent involvement. These subject characteristics are important to consider when analyzing and perhaps generalizing the results to a broader population.

Across all three studies, the researchers' interpretations of their statistical analysis were appropriate. All researchers discussed the limitations of their studies and hypothesized about the direction of future research.

Conclusions

A critical review of the literature has demonstrated that there is insufficient evidence to

suggest that cochlear implants impact literacy outcomes in children with hearing impairment. Although the studies examined provided strong arguments of a link between language and literacy (especially in the cochlear implant group) and there is evidence that children are using phonological strategies to decode unfamiliar words (perhaps attributed to the sounds afforded to them by the implant) it is not sufficient to suggest that the impact of the cochlear implant alone improves literacy outcomes in all children.

Recommendations

Although the available literature suggests the potential for cochlear implants to improve the literacy outcomes of children with hearing impairment, further recommendations can be made for future research and to assist clinicians working with this population.

Based on the evidence it is recommended that future research be conducted to provide a more consistent and representative view of the literacy skills of children with cochlear implants. First, it is suggested that the cochlear implant group be compared to a cohort of children who use traditional amplification (hearing aids) as opposed to children with normal hearing. Second, researchers should include information about the technical aspects of the cochlear implant (i.e., was it mapped appropriately?) Third, researchers should assess the literacy skills of children at various stages in their academic careers, perhaps in a longitudinal study. In the examined studies, all children were studied at the earlier stages of literacy development. Research needs to be conducted where children are required to complete more complex literacy tasks (involving analyzing, interpreting and creating texts) to measure the success of the cochlear implant on literacy skills.

By focusing future research on the areas of literacy that children with cochlear implants have difficulty with and certain stages in their literacy development that may hinder their academic success, appropriate support can be implemented by teachers, parents and clinicians.

Finally, if the purpose of these results is to generalize the findings to a larger population, research should conduct more complete and thorough statistical analysis to account for the effects of variables such as, age of implantation, type of therapy received, gender, socio-economic status, etc.

With the increased popularity of cochlear implants and the importance of literacy for a child's vocational, academic, social and emotional development, it is evident that this is a research area that should be further explored. It is hypothesized

that with earlier identification of hearing loss (through the Ontario Infant Hearing Program), children being implanted at an earlier age and therefore having more implant experience, future studies may result in strong, positive outcomes.

References

- Geers, A. (2003). Predictors of Reading Skill Development in Children with Early Cochlear Implantation. *Ear and Hearing, 24 (1)*, 59S-68S.
- Spencer, L., Barker, B., Tomblin, B. (2003). Exploring the Language and Literacy Outcomes of Pediatric Cochlear Implant Users. *Ear and Hearing, 24(3)*, 236-247.
- Watson, L. (2002). The literacy development of children with cochlear implants at age seven. *Deafness and Education International, 4(2)*, 84-98.