

Critical Review: Are there linguistic advantages of a total communication approach to education for children with cochlear implants compared to an oral approach?

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This critical review compares the linguistic performance of children with cochlear implants in total communication (TC) education programs and oral communication (OC) education programs. Five nonrandomized between group studies are discussed. Overall, research shows no statistical difference between the two educational approaches in all linguistic domains except for speech intelligibility and perception; where children educated in an oral approach demonstrated improved performance. Recommendations for future research and clinical practice are provided.

Introduction

Cochlear implant technology provides deaf children access to sound. Children who receive cochlear implants are a heterogeneous group, having a range of pre-implant characteristics and post-implant experiences (Nussbaum, 2004). These individual differences contribute to the use of and adaptation to the cochlear implant. The choice of educational programming for these children is one post-implant experience that can be controlled. Oftentimes parents look to professionals in the medical and educational fields to assist in determining what educational program is best for their child.

There are various opinions and methods related to the education of children with cochlear implants. The methods fall under two general approaches: oral communication (OC) and total communication (TC). The OC approach focuses on the development of spoken language. Children are not exposed to sign language and are required to rely on aural/oral communication for exchanges in the classroom. In the past, sign language for students with cochlear implants was rarely promoted. It was viewed by some professionals in the fields of medicine, audiology, speech-language pathology and education as deterring spoken language development (Nussbaum, 2004). Based on information from the Cochlear Implant Education Centre (CIEC) in Washington, D.C, as recently as 2004, it was reported that proponents of the OC approach maintained that using manual (signed) communication reduced the amount and consistency of spoken language stimulation. It was warned that using manual communication increased dependency on visual communication and may cause a delay in speech and expressive language development. However, research to date has found results that indicate the contrary. Studies of language outcomes for TC educated children with cochlear implants reveal strikingly different trends than do studies of speech perception and speech intelligibility outcomes (Robbins, 2002). It is believed that the use of a signed system may allow for easier assimilation of language through the unimpaired visual modality (Geers, 2002), and this may support and enhance spoken language development.

TC educational programs are defined as programs that use some form of sign language in addition to spoken language (Nevins & Chute, 1996; Ratner, 1997). In TC educational settings spoken

and written English and sign language are seen as equal languages and students are able use and have access to either language for learning. The continued development of a manual communication system along with spoken and written English is believed to be important for children with cochlear implants. Professionals who promote a TC educational approach for children with cochlear implants feel that there is a place for sign language as a post-implant opportunity. Those who align with this viewpoint maintain that sign language can be beneficial and that with careful attention and planning it can assist in maximizing spoken language and overall language acquisition. Furthermore, the ability to communicate bilingually will allow these children the choice of involvement in the Deaf community not only as children, but into their adult lives.

Parents who have a child with a cochlear implant have already made one tough decision, whether to implant their child or not. These parents then look for answers to the question of where and how their child should be educated, and they are often required to choose between either an oral or total communication approach.

Objectives

The primary objective of this paper is to critically evaluate the literature comparing the two main educational approaches for children using cochlear implants. The secondary objective is to propose evidence based suggestions for professionals and parents to assist in the decision-making process when considering educational placement for these children.

Methods

Search Strategy

Computerized databases, including Scholars Portal, PubMed and MEDLINE were searched. The following search strategy was used:

[Cochlear Implants AND [(ASL) OR (American Sign Language) OR (Sign Language)] OR [(oral communication) AND (total communication)]]

Hand searches of references cited in relevant articles were also conducted to identify further applicable resources. The search was limited to articles written in English and published between 1995 and 2008.

Selection Criteria

Studies selected for inclusion in this critical evaluation paper compared the OC and TC educational approaches for children with cochlear implants. The included articles were required to make comparisons between the two educational approaches based on linguistic and/ or social outcomes. Limits were not set on the demographics or socioeconomic statuses of research participants.

Data Collection

Results of the literature review yielded five non-randomized between-groups studies published in North America.

Results

While randomized control studies are considered to be the standard by which all other studies are judged, nonrandomized research designs arise from situations in which it is impossible or difficult to assign subjects to treatment by chance. Nonrandomized designs may be vulnerable to bias because of the inability to control the balance of factors between the groups. With regards to the present research question, relating to the educational programs for children with cochlear implants, researchers have no way of controlling the type of approach in which children are enrolled. This choice is one that is dependant on a variety of social, familial and personal factors. Therefore, nonrandomized between-groups designs are an appropriate way to compare these different educational approaches for children with cochlear implants.

Connor, Heiber, Arts & Zwolan (2000), compared consonant-production accuracy and vocabulary of children enrolled in OC and TC educational programs. The study was designed in a longitudinal pre and post test format, where data was collected before surgery and approximately yearly thereafter. A total of 147 children participated in this study, all of whom were prelingually deaf, had received their implant between the ages of one and ten, had nonverbal IQ scores within normal limits and had post-implant speech detection thresholds between 15 and 30 dB HL. Children were assigned to two groups based on the methods in which they received their education in the first three years of their schooling. Of the children included in this study, 66 were enrolled in total communication and 81 in oral communication educational environments. Participants were also divided into three groups based on age of implantation (Preschool – implanted before 5;0 years, Early Elementary – 5;0-6; 9 and Middle Elementary 7;0-9;9 years). Researchers assessed each student in the linguistic domains of consonant-production accuracy, receptive spoken vocabulary and expressive spoken and/ or signed vocabulary. Testing was conducted by three certified speech and language pathologists and well established standardized tests were given. Data were collected and a two-level Hierarchical Linear Modeling (HLM) was used to analyze growth curve trajectories in each linguistic domain for both educational approaches. The use of a HLM was considered to be advantageous to this study as it allowed researchers to compare all data at each interval using either age or length of implant use as continuous variables despite any known variations between participants. From the growth curves expected outcomes scores post-implant can be compared.

Consonant-production accuracy was transcribed and entered into PROPH+ software, which analyzed the data and determined a percent consonant correct score for each participant. The reliability of this scoring method was assessed using inter-task correlation, which yielded a reliability coefficient of .90; considered adequate for research purposes. When comparing consonant-production accuracy for OC and TC groups using the PROPH+ software, results indicated that that children in the OC group demonstrated expected consonant-production growth rates that improved more rapidly compared to the TC group. When receptive spoken English vocabulary was assessed in both groups of children, results revealed no significant difference in mean score and rates of growth. When scores of expressive vocabulary was analyzed through HLM, results indicated that the TC group demonstrated higher scores on average, than the OC group. However visual inspection of expected growth curves reveals that over time, growth rates appear to become similar. Thus, despite the initially greater expressive vocabulary those children in the TC group appeared to have, over time their performances can be considered to be statistically similar to the OC group. There was no statistically significant difference found between the two groups in the domains of receptive and expressive vocabulary.

Participant selection criteria should be considered as a strength of this study. Researchers made considerable attempt to control for possible influencing variables known to impact outcomes in cochlear implant users. An additional strength to this study is it's inclusion of established standardized tests for assessment in all linguistic domains. Questions were delivered to the students in an oral only format, with lip-reading permitted. In the expressive vocabulary assessment, researchers allowed participants to use their preferred method of communication. However, despite the considerable efforts to balance groups based on confounding variables, and create uniform testing environments, the results of this study should be interpreted conservatively. Researches grouped children based on the type of educational system they were enrolled in. While they based this grouping on a specific definition and criteria, considerable variation was reported in the methods in which OC and TC programs were delivered. This is especially the case for TC programs where there is no standardized practice throughout North America for when, where and how sign language is incorporated into the curriculum. Therefore, it is unwise to make comparisons without considering all multifaceted variables that may affect long-term outcomes. This further points to the complexity of studying children with cochlear implants and demonstrates how continued investigation is needed in this topic area.

Overall, this study provides evidence that is suggestive to compelling. Conclusions were established based on visual inspection of the data, and of HML generated growth curves in each linguistic domain, for both educational approaches. This research indicates that children with prelingual deafness receiving cochlear implants before age ten accomplished significant improvements in the measured linguistic domains over time, regardless of the methods of communication in their educational settings.

Geers et al. (2000), conducted a post-test study which examined the impact of various combinations of rehabilitation settings on

speech and language outcomes. Researchers in this study hypothesized that children who relied on speech and hearing for communication (OC educational approach) would develop higher levels of speech perception, production, language and reading skills than children who relied on both speech and sign (TC educational approach). In this study, 43 children were included. All participants were between the ages of eight and nine and used their implants for four to six years. Participants were enrolled in educational programs across Canada and the United States; 23 in TC based programs and 20 in OC based programs. Researchers attempted to control for variables known to influence cochlear implant use and performance. In doing this, they assessed individual characteristics of the participants using questionnaires, interviews and well established standardized tests. It was determined that there was no significant difference between the two groups in the areas of IQ, age of onset of deafness, age of implantation, median family income or median education of fathers. Groups did differ significantly in mother's education and number of hours of therapy received, where the children in the OC group had mother's with an average of two additional years of education and two times more speech and language therapy than the TC group post-implantation.

All participants completed a battery of tests taking six hours to complete over a three-day period. Well established standardized assessment tools focusing on speech perception, production, language and reading skills were used to collect information. Average scores obtained by TC and OC groups were analyzed using a t-test to assess whether mean scores of the two groups were statistically different from one another in each linguistic domain. This type of analysis is considered to be an appropriate measure for between groups comparison. Results indicated that children in the OC group scored significantly higher in speech perception abilities. Intelligibility was assessed by recording each child's production of the 32 McGarr sentences and played to three naïve listeners. Similar to the consonant-production accuracy measure in Connor, Heiber, Arts & Zwolan's (2000) study, intelligibility scores also showed that children educated in an oral approach had better performance. No significant difference between the groups were observed in average language and reading scores.

Also similar to Connor, Heiber, Arts & Zwolan's (2000) study, this experiment made considerable effort to control for variables known to impact outcomes in cochlear implant adaptation and use; such as age of implantation and non-verbal IQ. As well, all communication with the participants (except for measure of speech perception), regardless of educational program was done with simultaneous speech and sign. These factors, along with the use of well-established and valid assessment tools should be considered as strengths of this study. The definition used to denote TC education programs for the purpose of this study was broad and encompassed any program using some form of manually coded English. While this appears to be common practice in the realm of education for the hearing impaired, this lack of a standardized definition provides researcher no documented way to ensure equivalent amounts of sign language use within the TC group. Another concern is that participants did differ significantly in the amount of maternal education and number of hours of speech and language therapy received during the first three years post-implantation. The children in the OC

group were assessed to have a statistically significant advantage in both areas. Participants belonging to the OC group had mothers with two times more education, and two times more therapy compared to participants in the TC group. These are important between group differences to consider, and the researcher's failure to take these differences into account when analyzing and interpreting results is another limitation of this study. For example, the one area in which students in the OC group had considerably better scores was in speech production and perception; both areas likely to have been a significant focus in speech and language therapy. This failure to explore possible consequences of the doubled amount of speech therapy received by the OC group on their superior speech production and perception scores, along with the other mentioned limitations, lowers the level of evidence offered by this study. The conclusions made by this study should be considered as moderate to suggestive evidence.

Geers (2002), conducted another longitudinal study aimed at assessing the influence of educational programs (independent variable) on five dependant variables (speech perception, speech production, expressive and receptive language and reading) for children with cochlear implants. A series of multiple regression analyses determined the amount of variance in each outcome accounted for by the intervening variables (TC or OC education). A multiple regression analysis is considered an appropriate method for "predicting a given outcome based on identified factors" (Portney & Watkins 1999). This study took place over a four-year period where 180 eight and nine year-old children participated. Participants in each group were similar in regards to personal, family and implant characteristics. Results of this study demonstrated that classroom communication mode was not a predictor of better linguistic outcomes. When comparing both OC and TC education, there was no advantage exhibited for children in either group.

While this study does lend valuable information regarding the linguistic implications and outcomes for OC and TC education, methodology and research design variables brings limitations to the results. The primary purpose of Geers' research was to investigate the various factors known to contribute to cochlear implant performance outcomes. While the difference between the two educational approaches was examined as one of the numerous variables, specific information regarding the methodology of the study; data collection, and reliability and validity of measurement tools for each variable examined was poorly documented. Thus, while the results of this article concludes that the type of educational program a child with a cochlear implant is enrolled does not predict better linguistic performance, we must consider this evidence to be equivocal. The lack of information regarding study design limits comprehensive and critical appraisal this body of research.

Robbins, Bollard & Green (1999) examined the development of language skills in 23 prelingually and profoundly deaf children following implantation with the CLARION® Multi-Strategy™ Cochlear Implant. Fifteen of the children were enrolled in OC programs and eight in TC programs. Expressive and receptive language skills were assessed with the Reynell Developmental Language Scales (RDLS) and scores were gathered pre and post-operatively (approximately six months after implantation). The

RDLS was administered in the child's preferred method of communication (signed, spoken or both). The RDLS is considered to be an appropriate tool to collect data for this purpose. It is reported to have been extensively used with deaf children, and appropriate for use with a broad age range, allowing repeated measures over an extended time period. Repeated-measures analysis of variance was performed to analyze the results, with communication mode as the between subjects variable. Results that were examined were the mean age-equivalent scores at pre-implant and six-month post-implant. Results demonstrated no significant difference between expressive and receptive language scores for children enrolled in either OC or TC programs. For receptive language, the OC children achieved an average age-equivalent score of 21 months at the pre-implant interval and 30 months at the six-month post-implant interval. The TC group achieved an average age-equivalent score of 20 months before implantation and 28 months at the six-month post-implant interval. In the expressive language domain, there was also no significant difference in age-equivalent scores between the OC and TC groups. Overall, results demonstrated that although no significant differences were found as a function of educational communication mode, there was a trend for faster rates of language learning by OC children.

When critically appraising the design of this study, its strengths appear to be in the use of standardized tools to assess and make between group comparisons. As well, Robbins et al. were able to use both pre and post implant assessment results in which to support their conclusions; a factor considered to be exceptional since there is limited published research that includes a collection of data pre-implant in the study design. However, due to small sample size, particularly in the TC group, the authors of this study caution interpretation of results.

Robbins, Svirsky & Kirk (1997), also used the RDLS to evaluate English-language skills. In this study they initially compared the outcomes of deaf children with and without cochlear implants. They performed further analysis and divided implanted participants into two groups based on the communication method used in their education. Participants included in this study were 89 deaf children without cochlear implants and 23 implanted children (fourteen enrolled in TC, nine in OC). The RDLS was administered once to the non-implanted groups and in three intervals (one pre-implant and two post-implant) to the implanted group. The two post-implant assessments occurred at six and twelve months after surgery. Predicted scores were generated for each participant according to calculated regression equations, and two-way repeated-measures analysis of variance was conducted. Both types of analysis are considered appropriate for assessing hypothesized outcomes. Repeated measures occurred on both the "interval" and the "observed vs. predicted" variables. Results of this study indicated that observed language scores of participants with cochlear implants were significantly higher compared to participants without. This suggests that the cochlear implant promoted both receptive and expressive language development compared to maturation alone. Going a step further, comparisons were made based on educational placement of the cochlear implanted children. It was observed that regardless of educational placement (OC or TC), children demonstrated an increased and similar rate of language learning over time. At six months after

implantation the TC group made three months of progress beyond expectation based on maturation alone. The OC children, during the six month interval showed only one month progress beyond what was expected. At the 12 months post-implant assessment both the TC and OC groups averaged six months of language gain beyond expected.

Researchers acknowledge the inherent difficulty in assessing language improvement over time and determining to what extent maturation contributes to changes in performance. By considering this, they attempted to design their study in a way that offered explanation of how maturation may be expected to play a role in each group. This study is well designed and researchers made considerable effort to control for any additional variables known to impact cochlear implant performance (e.g. non verbal IQ or amount of speech therapy received), however despite the relatively sound study design, the minimal participants in each group should cause us to be critical when evaluating and interpreting results into professional practice.

Discussion and Recommendations

While each study does provide evidence that is moderate to compelling in this area of research, we must remain conservative in our interpretation of the results and application to clinical practice. While all studies grouped participants based on the type of communication of their educational program, there was a consensus across the data of non-standardization in the criteria for program types. Each study based their groupings on whether sign language was used in some capacity (TC approach), or not at all (OC approach). This has considerable implications for inconsistencies within the TC group. To date, there is no standard in North America for TC programs with regards to the frequency with which sign language is used in the classroom. Until such a standard can be made, cautious application of findings in this area of research will continue to be required.

In their attempt to control for known intervening variables on cochlear implant performance, Geers et al. (2000), noted difficulty ensuring consistency between groups in the amount of speech therapy received three years post-implantation. The researchers of this study did not further explore how this difference may have contributed to the advantage that was documented for OC educated children in speech perception and production abilities. This is a major implication for this field of research. This sparks concern that significant difference in speech and language therapy post-implantation may have been a variable not considered or further explored in the other literature examined in this critical review.

The longitudinal study design of the work by Robbins, Svirsky & Kirk (1997) and Connor, Heiber, Arts & Zwolan (2000) offer important results of performance longitudinally. Educational performance is not a variable that remains stagnant. Exploring the speech, language and reading abilities of children with cochlear implants over time may further enlighten the differences between the two educational approaches. While it may be concluded that when measured at six and twelve months post implant, children in one educational program have greater linguistic performances, this trend could change as the children progress with their education. This is especially the case for the

research presented by Connor et al (2000), who examined the linguistic growth rates of children in both educational programs across the all grades. This research offers a predicted picture of how academic and linguistic abilities may evolve over time. This particular body of research presents the most compelling evidence within all the literature compared in this critical appraisal. Furthermore, the findings from Conner et al. (2000) are frequently cited in similar literature and appear to be considered in the realm of evidence based practice as a good foundation in which to understand the differences between OC and TC education and for which to base additional research on.

As children with cochlear implants in both programs continue with their education, it is important that their progress be followed and documented. Since cochlear implantation is still considered to be a relatively new procedure, there is less information available regarding performances in high school and beyond. As well, it is important that future research comparing TC and OC approaches considers social implications. Some topics that future research may seek to explore could include:

- Social benefits or limitation of education in an oral communication and total communication environment..
- Trends of educational placement and association with Deaf culture and Deaf identity.
- Exploring how additional speech therapy for TC educated children disseminates the advantage that OC children are currently believed to have with regards to speech production and perception.

Parents, health care professionals, educators, researchers and policy makers should work towards a standardized curriculum for TC and OC programs across North America. It is further recommended that these individuals look to other countries, such as Sweden who have established such a standard and have literature available (Preisler et al. 1997 and 2005) demonstrating many positive long-term social, educational and cultural outcomes of a bilingual speech and sign communication system. Having additional and more concrete results, as well as a standardized curriculum for each style of education will assist in the making of informed educational choices designed to maximize a child's post implant communication development.

Conclusion

Within each of the two discussed types of education for children with cochlear implants, there are variations in the delivery and style of communication in the classroom. The lack of standardization in the delivery of education creates debate and concern among parents and professionals. There are benefits and limitations to each general approach. In this critical appraisal of the literature surrounding the compared linguistic performances of children with cochlear implants in TC and OC program, the following conclusion can be made.

- Children with cochlear implants in TC and OC educational settings showed no difference in their reading or expressive and receptive vocabulary.
- While some studies found an oral communication advantage in the linguistic domains of speech perception and production, the limitations in the research associated with these findings do not warrant concluding that an OC approach is better overall.

- Additional research is needed and should be considered essential in the exploration of differences between linguistic outcomes in children enrolled in either OC or TC programs. It is important that researcher continue to control for as many influencing variables as possible

As the technology of cochlear implants evolves, it is important and additional research is completed in order to develop stronger conclusions in this important topic. Since children, especially those with cochlear implants are such a heterogeneous population; we must carefully analyze the research that surrounds this topic and interpret results cautiously. Further research may assist in developing not only a standardized delivery of education for both TC and OC groups but assist in decreasing tension and debate surrounding the provision of education to children who are Deaf, hearing impaired or cochlear implant users.

Clinical Implications

When asked for a clinical opinion regarding how a child with a cochlear implant should be educated, clinicians need to be aware that there is no concrete answer. There is no cookie-cutter description of what type of child should have exposure to sign-language as part of their education and who should not. It is important the clinicians educate families on the benefits and limitations of both approaches and to encourage families to become familiar with both approaches, and speak with other parents who had made similar decisions.

Due to the overall moderate strength of evidence provided in the literature reviewed, it is suggested that clinicians use these findings cautiously when consulting to families of children with cochlear implants on educational placement. Despite the varying strengths of evidence and possible existence of known and unknown confounding variables, we are able to advise parents that there is no significant difference in average expressive and receptive language or reading scores of children enrolled in either program. As well, while there appears to be a mild advantage in speech production and perception abilities in children in oral communication based programs; it is likely that additional speech and language therapy contributes to this advantage and could assist in improving speech production and perception abilities in children from either educational approach.

While in the process of obtaining a cochlear implant, many parents begin communication with their child in sign language; as this is the easiest and most natural form of communication for them. If there is no overall linguistic advantage for children to immerse themselves in an oral only education system, why not continue to develop their sign language skills in synchronization with their aural/oral development. This allows for development of a second language that is shared with members of the Deaf community. If parents do wish their child the option of involvement with the Deaf community, especially later on in their adolescent and adult life, a total communication approach may be more advisable. With careful attention to individual progress and the provision of additional speech and language therapy as needed to assist with production and perceptual speech abilities, a child enrolled in a total communication education environment should not be considered to be at a linguistic disadvantage compared to their peers in oral only education.

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