

## Communication Mode and Expressive Language Outcomes in Children with Hearing Loss: A Critical Review

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**Abstract:** This critical review investigates the relationship between communication mode and expressive language outcomes. For the critical review, studies evaluated included four retrospective longitudinal cohort studies and one pre-test, post-test mixed design study. The results were mixed with some studies finding significant effects, some studies finding non-significant trends and some studies failing to find evidence of any effect whatsoever. Many studies addressed the effect of communication mode as a secondary or tertiary goal, or treated communication mode as a control variable, which served to further limit the validity of the results. Nonetheless, whenever an effect for communication mode was found, children who use auditory-verbal and oral communication are consistently found to perform better than children who use total communication with respect to measures of expressive language.

### *Introduction*

Concerns about language development serve as a primary motivator for fitting deaf or hard-of-hearing (DHH) children with cochlear implants. Although there is definitive evidence that cochlear implants improve DHH children's spoken language skills and that they can allow children to achieve age-appropriate language skills, outcomes have been found to vary greatly across individuals (Forli et al., 2011). Uncertainty surrounding the expected language development outcomes of DHH children with cochlear implants detrimentally complicates parents' decision-making process and makes it difficult for habilitation specialists to provide clear recommendations.

Several research studies have been conducted to attempt to find the factors responsible for explaining this variation. Factors that have been investigated include, but are certainly not limited to, age of diagnosis and implantation, pre-operative residual hearing, communication mode and parent involvement. While there is a general consensus about the benefit of early identification and implantation, recommendations are much less clear when it comes to the choice of communication mode that is most beneficial with respect to optimizing language development.

Many communication mode options exist for DHH children with cochlear implants which can be understood and compared to one another by considering them in the context of an auditory-visual spectrum. Auditory-based communication modes that emphasize the use of auditory linguistic input through spoken language and exclude the use of sign-language include auditory-verbal and auditory-oral communication. Auditory-oral communication is the default spoken-language habilitation approach that is usually facilitated by special-needs educators in institutional group-settings that aim (1) to help DHH children acquire age-

appropriate spoken language by listening and by attending to visually accessible contextual cues (2) to integrate DHH children into mainstream education and society as a long-term goal (Thomas & Zwolan, 2019). The auditory-verbal approach, usually referred to as Auditory-Verbal Therapy (AVT) aims to expedite mainstreaming DHH children as much as possible by having a Listening and Spoken language specialist Certified Auditory-Verbal Therapist coach parents to lead one-on-one habilitation efforts and to create a rich spoken language environment at home while minimizing reliance on visual cues as much as possible (Thomas & Zwolan, 2019). Communication modes that emphasize the use of visual linguistic input include sign-language systems and may involve additional visual supports such as lip reading and cued speech. Alternatively, total communication is an approach wherein a customized combination of both auditory and visual linguistic input is used to facilitate language comprehension and production in a way that is meant to suit the individual needs of each child.

Given the lack of consensus with respect to which communication mode is recommended to guarantee the best possible language development outcomes, an examination of the existing literature is warranted in order to elucidate the relationship between choice of communication mode and language development outcomes and facilitate evidence-based recommendations and courses of action on the part of clinicians and caregivers to DHH children. In the interest of narrowing the scope of this critical review, the investigation is limited to comparing the most common communication modes (i.e. auditory-based communication and total communication) and language development outcomes considered are limited to measures of expressive language.

## ***Objectives***

The focus of this critical analysis is to investigate (1) whether communication mode is a predictive factor of expressive language outcomes in DHH children fitted with cochlear implants; (2) whether auditory-based communication or total communication approaches are associated with better expressive language outcomes.

## ***Methods***

### Search Strategy:

Several computerized databases were searched (PubMed, Web of Science, Scopus, PSYCHINFO and ASHA Publications) to retrieve relevant journal articles using the following search terms:

(cochlear implant\*) AND (communication mode) AND (expressive language) AND (total communication) AND [(auditory-verbal) OR (auditory-oral) OR (oral communication) OR (oral approach)]

### Selection Criteria

Studies selected for inclusion in this critical review were required to (1) include communication mode as a predictor or between-subjects variable; (2) include a comparison between an auditory-based communication approach and a communication mode that incorporates signs; and (3) explicitly assess expressive language outcome across both communication mode groups.

### Data Collection:

Results of this literature search yielded five articles, including four level 2c retrospective longitudinal cohort studies and level 2c two-group pre-test post-test mixed-design study.

## ***Results***

### Retrospective Longitudinal Cohort Study Designs:

Retrospective longitudinal cohort studies are an appropriate design for comparing differences in long-term outcomes between two groups of a shared population like DHH children with cochlear implants who have received a different exposure condition (i.e. communication mode approach). Therefore, the validity and generalizability of the evidence provided by these studies is dependent upon the studies' efforts and abilities to systematically account for and limit these biases. Furthermore, as a quasi-experimental design-type, none of the effects found between communication mode and expressive language outcomes in these studies can be attributed to a cause-effect relationship.

**Thomas & Zwolan (2019)** investigated how speech and language outcomes are differentially associated with children exposed to auditory-verbal therapy (AVT) compared to those who used auditory-oral communication (OC) and total communication (TC). Participants included 203 children with severe-to-profound or severe bilateral deafness who had received cochlear implants by the age of five and were all sampled from a habilitation clinic affiliated with the authors of the study. The authors hypothesized that auditory-verbal therapy would be associated with better speech and language outcomes than other communication modes.

Speech, literacy, and language assessment data over a period of up to seven years post-implantation were examined retrospectively as outcome measures.

Expressive language, the outcome measure of concern for the present review, was assessed using the Expressive Vocabulary Test (EVT) from the Woodcock Johnson Tests of Achievement III and IV. Consistent with the authors' hypothesis, ANOVA results revealed that the percentage of children whose scores fell within the range of normal on the EVT was significantly higher for the children in the AV group compared to the OC and TC. Furthermore, results of the linear mixed model analysis showed that children in the AV group had significantly higher scores on the EVT, as well as on all other test measures of receptive language, literacy, and speech intelligibility, at all testing intervals.

Several measures were taken to increase the validity of the study's evidence. Subject selection and categorization criteria were specifically and clearly explained. The strict selection criteria helped eliminate some risk of confounding bias by limiting the age-of-implantation range, excluding participants that presented with cognitive or cochlear anomalies, and affirming that all participants had consistently used one communication mode. Appropriate assessment tools were used to assess expressive vocabulary outcomes and appropriate statistical analyses were performed to interpret results including an analysis of variance (i.e. ANOVA) to determine significant moderating variables of SES and age at implant, another analysis of variance to compare percentages of children in each group to achieve scores within normal limits, as well as a linear mixed model to determine the effect of communication mode on expressive vocabulary and other language-related outcomes. In addition to aspects of the study's design that contributed to the study's validity, the consistency of the results across both statistical analyses and across multiple time intervals increases the validity of the results as well.

A limitation of the study, however, is that some patients missed were unable to be assessed at each interval and that some patients did not complete every assessment and each interval. Furthermore, expressive language was only assessed with respect to expressive vocabulary. However, the consistently higher scores achieved by the AV group across all other speech and language domains serves to suggest that AV children may be more likely to perform better than children in OC and TC groups in other areas of expressive language, as well. Another limitation is the possibility that other confounding variables may not have been considered or accounted for.

Overall, this study presents fairly compelling evidence that DHH children with cochlear implants received in early childhood are more likely to have expressive language skills that approximate those of children with normal hearing compared to children exposed to auditory-oral or total communication approach to habilitation.

**Dunn et al. (2014)** conducted a study that sought to (1) examine how age of implantation affects speech and language outcomes (2) identify additional factors influencing speech and language outcomes in children with cochlear implants, including the factor of relevance to this critical of review (i.e. communication mode). Subjects of the study included 83 children with prelingual hearing loss who received cochlear implants before four years old and who were sampled from a single research center database. The children were divided into two groups by age at implantation. The first group received their implants before they were 2 years old, and the other group received their implants between 2-3.9 years. No hypothesis for the effect of communication mode is explicitly stated. The study compared the differences in mean scores on several language related outcome measures, including expressive language, between these groups every year post implantation from the ages of 7-11 years old. Expressive language was assessed using the Formulated Sentences subtest of the CELF-3 and a linear mixed model analysis was performed to interpret the data. The results of the study found a non-significant trend of higher expressive language scores for the oral communication group compared to the total communication group.

Strengths of the study relevant to the critical review include the use of an appropriate assessment tool to measure expressive language outcomes, implementation of appropriate statistical analyses (i.e. linear mixed model framework). The study also employed several measures to control for confounding variables by ensuring that there was no systematic

variation between the two groups other than age-at-implantation including preoperative residual hearing, initial age of pre-operative hearing aid use, maternal education level, nonverbal cognitive skills, amount of weekly service provision and communication mode. However, since the subjects were not grouped based on communication mode (i.e. communication mode was treated as a control variable), evidence pertaining to the effect of communication mode on expressive language outcomes may be subject to confounding effects. That is, there may have been systematic variability between oral communication and total communication groups that could have contributed to the observed trend of higher expressive language scores among the children who use OC compared to those who use TC. The assessment tool used to measure expressive language outcomes is well-established and valid. Overall, this study provides equivocal evidence that oral communication may be associated with better expressive language performance compared to total communication.

**Boons et al. (2012)** sought to determine language skill benchmarks in children with cochlear implants and to determine factors that explain variability of language outcomes in children with cochlear implants. Subjects included 288 prelingually deaf children who received cochlear implants prior to age 5, sampled from a collection of clinics. No hypothesis for the effect of communication mode is explicitly stated. A multiple regression analysis was performed to analyze how nine child-related, auditory and environmental factors, including communication mode, were examined to determine their influence on several outcome measures, including expressive language. Expressive language outcomes were assessed each year post-implantation for three years using The Schlichting Expressive Language Scale, a well-established and valid assessment tool. Results of the regression analysis showed that children who used oral communication demonstrated significantly higher word-level expressive language scores compared to children who used total communication. Interestingly, a significant effect was not found for scores evaluating expressive language at the sentence-level.

Strengths of this study include large-sample size that allowed for examination of many moderating factors, specific and well-defined participant selection criteria designed to reduce extraneous variability (e.g. excluding children with cognitive delays), clear description of unique participant characteristics (e.g. number of participants with implantation complications during time-course of study), post-hoc confirmation of absence of outliers. A limitation of this study relevant to the purposes of this review is that the subtest selected

to measure expressive language at the sentence-level was a sentence-repetition task which is not highly representative of overall expressive language skills at the sentence. As the authors of this study explain, this may explain why no significant effect was found at the sentence level, as it may be the case an effect involving communication mode may only be evident for language tasks that have a greater linguistic skill demand than a sentence-repetition task.

Overall, this study presents suggestive evidence that the use of oral communication is correlated with improved expressive vocabulary skills compared to the use of total communication.

**Kirk, Miyamoto, Ying & Perdeu (2000)** investigated the relationship between the rate of growth in language skills and age at implantation. As a secondary aim, the study sought to determine how communication mode moderates this relationship. Subjects of the study included 106 prelingually deaf children with severe and profound hearing loss who received cochlear implants and were sampled from a separate longitudinal study. The study used a mixed model analysis to examine the covariates of length of device use, age at implantation and communication mode. Language skills, including expressive language, were assessed with Reynell's Developmental Language Scales which was administered pre-operatively and then post-operatively every six months for a period of three years. Results of analyses of variance with repeated measures revealed no significant effect of communication mode on the development of expressive language abilities. No hypothesis for the effect of communication mode is explicitly stated.

Strengths of this study include use of appropriate statistical analyses for a repeated-measures design study, and the use of a well-established and valid assessment tool to measure expressive language outcomes. A limitation of this study includes the risk of selection bias given that the authors do not explain how communication mode was determined for each participant (e.g. clinical records, parent report). Another limitation was that the number of data points varied across children due to children's lack of availability for testing at every interval, children's attentional limits, and general time constraints. Several possible moderating variables The study also does not describe the expressive language tasks from the RDLS in detail, thus it is difficult to infer whether some feature of the assessment or the way it was administered may be responsible for the absence of a significant effect of communication mode on expressive language measures. Finally, since only a few covariates were considered, there may have been an unknown

variable that systematically varied between communication mode groups that could have obscured the studies ability to find a significant effect. For example, if the total communication group that was sampled happened to have higher SES compared to the oral communication group, and if SES significantly affected expressive language outcomes, controlling for SES could reveal an effect between communication mode groups that would have been obscured if this variable were not controlled.

Overall, this study presents equivocal evidence regarding the relationship between communication mode and expressive language outcomes and does not provide enough evidence to refute the null hypothesis that communication mode has no effect on expressive language outcomes.

Two-Group Post-Test, Pre-Test Mixed Design Study: **Robbins, Bollard & Green (1999)** conducted mixed design study to examine language development outcomes in profoundly deaf children after receiving CLARION implant and to evaluate the relationship between post-implantation language skills and preoperative communication mode. Subjects of the study included 23 prelingually, profoundly deaf children who were implanted with a particular brand of cochlear implant between the ages of two and five. Receptive and expressive language skills were assessed with Reynell's Developmental Language Scales (RDLS) which was administered preoperatively and then once again post-operatively after 6 months of implant use. The study concerned both absolute age-equivalent scores as well as the rate of improvement between the pre-test and post-test interval. Repeated-measures analysis of variance was used to analyze the data, such that the interval served as the within subjects variable and communication mode served as the between subjects variable. With respect to absolute age-equivalent scores on the expressive language subtest of the RDLS, results revealed that there was no significant difference found between the communication mode groups. With respect to rate of improvement from pre-test to post-test, a non-significant trend was observed where children in the oral communication group had a faster language learning rate than children in the total communication group.

Strengths of this study includes clear description of participant selection criteria, use of appropriate assessment tools (RDLS) and statistical analyses (repeated measures analysis of variance), and that the study examined both absolute scores and rate of improvement for a more comprehensive comparative profile between the communication mode groups. The validity of the evidence was limited due to the small

sample size of this study, which the authors noted made it not possible to account for missing data points in their statistical analysis. Other limitations include that the study did not monitor whether communication mode was consistent throughout the duration of the study and that they did not take enough measures to control for extraneous sources of variability (e.g. residual hearing) between the two groups. No hypothesis for the effect of communication mode is explicitly stated. This study provides equivocal evidence regarding the relationship between communication mode and expressive language outcomes.

### ***Discussion***

Overall, the literature is not entirely consistent on whether communication mode is a predictive factor of expressive language outcomes in DHH children with CI's. However, whenever a significant effect or an effect approaching significance is found, oral communication approaches are found to be more likely to be associated with better expressive language outcomes. With that said, most of the studies were subject to limitations that substantially limited the validity and utility of the findings, especially with regard to insufficient controlling of sources of extraneous variability between communication mode groups. Furthermore, examining effects or influences of communication mode on language outcomes was frequently a secondary or tertiary goal of the studies in question, thus many of the measures taken to increase the validity of the studies were designed to be relevant to the study's primary goals rather than the goals of this critical review. However, the study by Thomas & Zwolan (2019) puts forward compelling, highly consistent evidence about the increased likelihood of improved language development outcomes, including expressive vocabulary associated with exposure to auditory-verbal therapy over auditory-oral and total communication that should be explored in even greater detail in future studies.

A more general limitation of the results of this critical review is that researchers are limited in their ability to conduct experimental designs due to ethical and practical considerations, thus the literature was largely limited to longitudinal cohort designs which are limited in their level of evidence due to potential for selection bias, lack of a true control group, high likelihood of attrition and difficulty controlling for many possible variables, especially for retrospective designs. Furthermore, the level of evidence provided by the studies in this review does not allow for causal interpretations where effects are found between communication modes and expressive language outcomes.

Several factors could have contributed to the inconsistencies between the studies' ability to find a significant effect.

- Different studies controlled for different variables.
- Different studies used different assessment tools.
- Different studies employed different inclusion/exclusion criteria for participants.
- Different studies had different numbers of participants.

### ***Recommendations***

Future studies should:

Make efforts to index and control for as many potentially confounding variables as possible OR use strict selection criteria to minimize variability between-groups outside of the independent variable.

- Ensure a sample size large enough to be able to account for missing data points that are likely to occur for longitudinal studies
- Clearly describe all methods, assessment procedures to make results amenable to reproduction and comparison.
- Highly consistent results among several well-designed longitudinal studies can result in a compelling pile of evidence in favor of one communication mode over another.

### ***Clinical Implications***

Due to the limited strength of the evidence in the literature, clinicians are advised to exercise flexible decision-making and should strongly consider patient preferences for communication mode.

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