Critical Review:

Are augmentative and alternative communication interventions an effective method of enhancing language development in children who are deaf or hard of hearing?

Melissa Posocco
M.Cl.Sc. (SLP) Candidate
University of Western Ontario: School of Communication Sciences and Disorders

Abstract: Children that lack the exposure to rich language environments during critical periods of development are at risk for reduced language outcomes (Costantino & Bonati, 2014; Snodgrass et al., 2013). This critical review examined evidence related to AAC interventions and their influence on language development in children who are deaf or hard of hearing (DHH). The study designs included consist of scoping and systematic reviews, a case study, a multiple baseline design, a variation of a single subject multiple baseline design and a single-case experimental design. Overall, the research indicated that there is promise in incorporating AAC into therapy sessions however, more research is required to verify these findings.

Introduction

Children who are deaf or hard of hearing (DHH) have reduced access to sound and as a result, have limited exposure to language in their environment (Snodgrass et al., 2013). Costantino & Bonati (2014) reported that prior to language acquisition, less than 0.1% of child have severe to profound hearing loss; Meinzen-Derr et al. (2019) also noted that congenital hearing loss, within the United States, included one to three of 1000 infants per year. DHH children who demonstrate developmental delays, compared to their peers, must be provided with opportunities to apply and progress their communication capabilities (Snodgrass et al., 2013). Implementing an augmentative and alternative communication (AAC) approach can enrich a child's lexical knowledge and enhance the language development of this population (Davis et al., 2010). However, many parents are weary of relying on alternative methods to benefit their child's language development (Davis et al., 2010; Meinzen-Derr et al., 2017). AAC is a nonverbal method of communication usually needed by individuals with speech-language impairments, to express thoughts, requests or ideas and to support functional communication (Costantino & Bonati, 2014; Meinzen-Derr et al., 2019). AAC techniques range from unaided, requiring no equipment to aided, requiring equipment; AAC devices can range from sign language, to pointing, to communication boards to tablets (Davis et al., 2010; Meinzen-Derr et al. (2019). AAC selection is based on the individual's needs such as, if the child knows American Sign Language (ASL) and can utilize this as their method of communication (Davis et al., 2010). Similarly, tablet applications, can be tailored to individual needs, e.g., providing visuals to support language acquisition, facilitating utterance expansion and utilizing voice output to allow for self-monitoring (Meinzen-Derr et al., 2017). Overall, there are multiple forms of AAC available to meet individual language needs (Costantino & Bonati, 2014).

The value in this critical review is coupled with its utility in clinical settings. Researchers such as, Meinzen-Derr et al. (2019), have investigated the benefits of AAC interventions on the language development of children who are DHH. Consistent findings reflect the utility in the progression of language development in children with hearing loss. It is critical for clinicians to be aware of this innovative therapy approach, as children with hearing loss have less exposure to sound thus, putting them at risk for language delay (Meinzen-Derr et al., 2017). Overall, it is advantageous to investigate this method of intervention as it can provide an innovative approach to language therapy.

Objectives

The purpose of this investigation was to evaluate the evidence of the effectiveness of AAC interventions for enhancing language development in children who are DHH. This review also offers clinical recommendations to Speech Language Pathologists.

Methods

Search Strategy

Articles related to the objective of this report were obtained through the following databases: Google Scholar, Medline and PubMed. Keywords inputted for the database search, included:

Language therapy and deafness and AAC
Deafness and hard of hearing and language or AAC
Language therapy and children deafness

Child hearing loss and language and AAC

Articles were only considered if they were written in English.

Selection Criteria

In order to be included in the review, studies were required to discuss language outcomes and AAC techniques for DHH children.

Data Collection

A total of six articles met the inclusion criteria. Of the six studies, there was one systematic review, one scoping review, a multiple baseline design, a variation of a single subject multiple baseline design, one case study, and one single subject experimental design.

Results

Costantino and Bonati (2014) have completed a scoping review to discuss the impact of AAC interventions on the language development of children with limited speech and language skills. The inclusion criteria for their review consisted of only randomized control trials (RCTs), individuals under 18 years of age, the use of a specified AAC intervention, the involvement of comparative groups and intervention outcomes, and randomized comparisons, among intervention and control groups. This investigation included participants that were either typically developing or had some form of disability. A scoping review gathers data on a topic to identify opportunities or gaps in the literature, however, with a broader research question than a systematic review (University of Toronto Libraries: Gerstein Science Information Centre, 2020).

The authors utilized several search engines to obtain journal articles. The two researchers found 14 papers that met the inclusion criteria, with 666 children included in the collected data. Kappa statistics were utilized to solidify the inclusion criteria. Each author independently used the standardized criteria to evaluate the quality of each study; the Delphi list was used to assess the presence of randomization, unbiased treatment distributions, varying baseline levels among participants, as well as intention to treat analysis. This tool generated unweighted scores from poor to high quality, ranging from zero to nine. A second point scale, the Jadad, was utilized to evaluate concerns, such as, biased data; three items on this scale were associated with mitigating bias, as well as, another seven items, with scores between zero to ten, including, assessments, objectives, outcome measures, inclusion and exclusion criteria, sample size, interventions, control group, and statistical analysis. Authors then discussed their scores and concerns. Outcomes varied between the 14 studies; however, researchers emphasized that implementing AAC early in development can contribute language gains in this population.

Strengths found in this study included the detailed methodology surrounding their research design. A limitation in this report is the very small sample sizes included in the studies within this review. Also, authors reported that the restrictiveness of RCTs may have limited the study's findings of practical and clinical effectiveness, e.g., the child communicating with varying partners, such as, grandparents, teachers etc. Further, barriers to AAC intervention were addressed, such as, resource availably, professionals not being adequately trained and reporting to not have enough time to devote to the training. Additionally, a caveat in this resource is that this study did not directly specify including children with hearing loss; however, it provided productive data on the utility of AAC on language development for children with limited language skills.

This report provided somewhat suggestive evidence on the impact of AAC intervention of progressing the language outcomes in children.

Meinzen-Derr et al. (2019) conducted a multiple baseline investigation to evaluate the impact of AAC intervention on spoken language outcomes in young children who are DHH. Specifically, this study implemented, spoken core word language strategies within their speech-language therapy. Their research comprised of high-tech AAC strategies in speech-language therapy with children who are DHH. Participants included 11 young children, aged 3:11 to 10:8, with bilateral heading loss; the origin of hearing loss was related to enlarged vestibular aqueduct, cytomegalovirus infection in-utero, genetic causes, and other unknown causes. Multiple baseline research designs include measurements being taken once, from baseline to treatment, and replicated between varying clients, situational environments and client behaviors (Morgan & Morgan, 2008).

The sessions were tailored to the children's goals within six week cycles, including family participation and each session being one hour in length. The intervention used *TouchChat HD© with WordPower* on an iPad, generating language with core vocabulary, consisting of commonly used words, and fringe vocabulary, including words relevant to a certain topic, environment or communication partner (Murphy, 2010). These two types of words are used within grammatical sentences, with opportunities to modify morphology. The device was used to ask "wh" questions, model, prompt higher

level language, reinforce, and expand utterances; with instruction to the child to verbally produce the message after creating it on the device to diminish their reliance on the tablet's production of language. The first six-week cycle began with the SLP leading sessions and introducing and explaining the functions of the device to the child and family. The second cycle, week seven-12, included self-guided at-home therapy in each family. Week 13-18 they returned to sessions with SLP, then completed the final six weeks, week 18-24, at home. Upon completing the last week, the children were reassessed and another language sample was obtained.

Statistical analysis revealed an increase in mean length of utterance (MLUs), number of words spoken and mean turn length. Further, pragmatic development was also noted post intervention.

The strengths of this investigation included that the researchers ensured all participants used the same devices, which supported consistency throughout the investigation. Researchers also provided detailed steps of how results were acquired and identified possible disruptions to data collection, e.g., a student being ill, possibility hindering their performance for the day. However, limitations in the study included the small sample size and there being no control group. Further, they also did not monitor iPad usage time or have past language samples to reflect the participants' language trajectory.

Overall, this report provided data of suggestive evidence to implementing AAC techniques into speech and language therapy settings to improve the language development of children who are DHH.

Meinzen-Derr et al. (2017) conducted a single subject experimental design, to evaluate the impact of AAC technology on language development of children who are deaf and blind. Participants included five children, five to ten years of age, with permanent bilateral hearing loss and four that had cochlear implants, in a 24 week individualized program, with no control group. A single subject research design includes repeated assessments throughout an intervention; highlighting the client's progress within an experiment (Coffee, 2011).

Researchers recruited participants through mail, phone calls, and by assessing their data from a previous study. The inclusion consisted of the first five participants to complete the Technology-Assisted Language Intervention pilot program and if the child displayed a significant language gap (85% or less) in standardized assessments of the Preschool Language Scale 5th edition and the Letter International Performance Scale-Revised (nonverbal IQ). In this 24 week program, each child was given an iPad mini with only the *TouchChat HD© with WordPower* application downloaded. Interventions were planned based on age and individual communication needs, e.g., older children required the use of more vocabulary and morpheme use. The intervention timeline consisted of alternating settings every six weeks between being on site, with the SLP leading sessions, and at home, with family-guided use of the iPad. Caregivers could reach out to the SLP, if needed. After the final six-week session, the child was reassessed by the SLP.

Statistical analysis indicated improved MLUs and varied spoken words with an overall progressive advancement in expressive communication.

Strengths in this report consisted of appropriate criterion for participant eligibility to evaluate the research question, as well as, caregiver involvement to facilitate carryover. Limitations included possible discrepancies in the data, e.g., no control group and interruptions in data collection due to absences. Further, deaf-blind children often have multiple cognitive and developmental disabilities and it made the analysis of results difficult to decipher.

Overall, this article provided suggestive evidence for AAC to support the language development of children DHH.

Snodgrass et al. (2013) generated a variation of a single subject multiple baseline design, across four stimuli. The researchers aimed to have the child identify tactile symbols, for the words 'more,' 'done,' and 'new,' to build his AAC vocabulary and support his expressive communication. The only participant in this study was a nine year old boy with multiple disabilities, such as, intellectual disability and deaf-blindness; the data will be discussed in relation to his language goals outlined in his Independent Education Plan (IEP). His main source of communication was through gestures, e.g., smiling or crying.

No formal assessments were conducted but the family and team agreed on a modified PECS system with tactile symbols, rather than using the standard method of using pictures as a method to communicate. Researchers also considered the child's IEP that indicated his language goals, e.g., expressive communication and tactile symbol use. Symbolic communication behaviours were assigned words and he was taught to use tactile symbols to communicate. He utilized instruction comparably to how an individual would respond to a PECS-style of instruction. Two

adults were always present in session, with specified roles as the communication or physical partner, e.g., the physical partner guided tactile prompts to support the child's hearing loss. While the physical prompter placed the child's hand on the symbol, the communication partner then orally dictated words that matched the symbol, e.g., "MORE: you want more." To generate a baseline, the boy was introduced to a stimulus and engaged with it for 30 seconds before it was taken away. Upon obtaining a baseline, the facilitators began the introduction of the modified PECS intervention. The boy was only corrected if a non-symbol exchange was conducted, such as screaming or whining; this method of communication is difficult for listeners to interpret. Trials took place in the child's special education classroom. Trials consisted of a completion of steps for one stimuli, which were video recorded, and ranged from zero to 17 per day and tailored to factors in his day, such as his interest and mood; stimuli included, food or cup for 'more,' face washing or brushing teeth for 'done,' and thunder tube and slinky for 'new.' Correct trials were measured by him independently reaching towards the tactile symbol with each stimulus accumulating individual scores for each trial day. The ceiling benchmark consisted of correct responses on 60% or more per day, for three consecutive days. A maximum of 15 days of not reaching the criterion meant that the researchers began the next stimulus. Continual baseline and maintenance data collection occurred at the end of each intervention and continued for the entire school year.

Statistical analysis revealed that by the end of the investigation, the boy completed every step in the trials. The results indicated that, in conjunction with previous studies, when combined with systematic prompting, PECS and picture exchange methods, such as those with tactile symbols, demonstrated promising results to improving expressive communication. The child consistently demonstrated his ability to utilize symbols to make a request.

Strengths in this study included the detailed criteria of correct responses and performance expectations for each trial. Additionally, that the child could use three symbols to convey various intentions in different situations; the use of core vocabulary offered diverse opportunities to functionally communicate. Limitations included the use of one participant, and his multiple disabilities, as it was difficult to conclude findings without caveats relating to hearing loss and language development. Further, the lack of formal assessments and the disruptions in protocol may have interfered with data collection, for example, scheduling issues that led to no measurements being taken for a stimulus on some days and trials being done in natural settings creating a lack of control on the environment; however, this may be beneficial for carryover.

Overall, this report provided suggestive evidence of AAC interventions supporting children with hearing loss in their language development.

Davis et al. (2010) conducted a systematic review of experimentally designed studies. This review evaluated the utility of electronic or non-electronic, AAC techniques and the value they can have on individuals with hearing loss and disabilities. Participants were between one to 21 years old, with a total of 32 total participants. Children between five to 12 years of age made up 16% of the sample and those under four years of age consisted of 13% of the sample. Researchers also indicated participants' prior methods of communication, e.g., gestures, ASL or low tech AAC. In contrast to a scoping review, a systematic review gathers data on a topic to identify opportunities or gaps in the literature with a specific and focused research question (University of Toronto Libraries: Gerstein Science Information Centre, 2020). This review included, various disabilities and general elements of communication, but this analysis will focus on AAC relating to DHH and language outcomes.

Researchers used 27 databases, such as, PsychINFO, PsycARTICLES and MEDLINE, to search for relevant and appropriate articles; 14 articles were included in this review. Unanimous decisions were made regarding study inclusions and two scoring errors that were discovered were corrected. The inclusion criteria of the review consisted of reports using an aided AAC system to support expressive communication; an intervention-based approach, with participants seeking improvement on communication abilities; as well as, requiring a permanent hearing loss with one or more additional disabilities; and that each study consisted of an experimental design in their investigation on an AAC system.

The review suggested that AAC devices provide maximum benefit when implemented prior to other communication systems failing. AAC should be viewed as the starting point while a child is developing their language skills; early stages of development are critical and AAC can support a child's self-expression and foundational language skills. Overall, integrating AAC into an intervention can mitigate communication or language delays.

A strength in this study is that it provided practical and clear instructions on when to introduce AAC to a child with hearing loss. Limitations surrounded the broad criteria of disability, e.g., one or more additional

disabilities, as well as a broad age ranges; these vague criteria make the results difficult to compare to children with only hearing loss.

This review provided suggestive evidence that AAC interventions are effective at supporting language development in children with hearing loss.

Shibata et al. (2017) conducted a case study to address the impact of Information Technology devices on the communication of children who are hard of hearing. The study included Japanese children who are hard of hearing or have developmental disorders; participants ages were not specified however, attached images implied preschool aged children. A case study is an investigation of an individual or group in their natural setting (Heale & Twycross, 2018).

This research was built on an application that supported young children who are hard of hearing to progress their self-expression, e.g., through picture registration and sequence making. The main functions of the application included adding pictures or pictograms, speech recognition capable of identifying words used in real conversation and to store and align speech with associated photographs and pictograms, as well as, editing sequencing of stored photos. The application consisted of a communication and scheduling mode, but this review will only focus on the communication and language aspect of the application.

Statistical analysis demonstrated this application can be useful for spoken language development, e.g., when a child narrates their daily routines. The results indicated that AAC produced improved communication through multi-media approaches, e.g., texts, sounds and images.

Strengths in the study included the beneficial effect that technology can have on the language development of children with hearing loss. The limitations surrounded the structure of the trial designs not being specified, e.g., how often or how long each child used the application, the duration of the intervention, as well as, the age range of the participants being vague and broadly described.

Overall, this report provided equivocal evidence in investigating the impact of Information Technology devices on the communication of children who are DHH. Limitations in their research design should be considered when analyzing their results.

Discussion

This critical review aimed to investigate the effect of AAC interventions on the language development of children who are DHH. The articles demonstrated consistent support for AAC devices to improve language development in this population however, with some caveats to its usage. It was consistently advised that AAC has the potential to facilitate children with hearing loss in developing their language to communicate basic wants and needs, develop relationships, support their quality of life and allow for self-expression (Costantino & Bonati, 2014; Davis et al. 2010; Meinzen-Derr et al. 2019; Shibata et al., 2017). The researchers' findings discussed the progress made in MLUs and spoken language development as well as, myths of AAC causing detriments to a child's spoken language (Davis et al., 2010; Meinzen-Derr et al., 2017; Meinzen-Derr et al., 2019). Further, the impact of family involvement to support consistent use of AAC at home, as well as in therapy sessions, was also demonstrated (Meinzen-Derr et al., 2017; Meinzen-Derr et al., 2019; Snodgrass et al., 2013). Overall, researchers revealed the positive effects that low or high tech AAC can have in building a foundation for language and functional communication (Costantino & Bonati, 2014; Davis et al., 2010; Meinzen-Derr et al., 2017; Meinzen-Derr et al., 2019; Shibata et al., 2017; Snodgrass et al., 2013).

This review revealed advantages of AAC for language development in children DHH however, it highlighted several limitations to the evidence. Future analysis should consider the consistency between the type of AAC methods used within reviews, as well as, intervention studies monitoring the duration of AAC usage per day or session (Costantino & Bonati, 2014; Meinzen-Derr et al., 2019; Shibata et al., 2017). Researchers should be mindful of their assembled participants, as a lack of detail can be concerning, for example, limited specification of the participants' ages and disabilities (Shibata et al., 2017). Additionally, Shibata et al.'s (2017) tablet application may be limited in its applicability to other populations as all of their participants were Japanese and the content of the application may include culturally relevant features which may not accurately translate within other demographics. Similarly, the inclusion of participants with multi complex communication needs hindered the interpretation of the data (Meinzen-Derr et al., 2017; Snodgrass et al., 2013), e.g., the results are not as clearly linked to individuals with solely hearing loss; thus, it was challenging to locate research solely focused on children with hearing loss, without additional disabilities. Further, the quality of research designs should be optimized to support data accuracy, e.g., monitoring the exact time length of an intervention to maximize post assessment results (Shibata et al., 2017). Overall, the findings in this review demonstrated possible limitations in the literature however, that AAC

can be expected to provide benefit to the language development of children who are DHH.

Conclusion

The expected utility of AAC implementation to support the language development of children who are DHH is demonstrated throughout this review. Despite limitations in the research designs of several of the evaluated studies, AAC strategies can enhance the language development of children who are DHH.

Clinical Implications

Overall, this critical review offered support for clinicians to utilize AAC as a method to progress the language of children who are DHH. The literature ranges in quality, however, practical options were provided, e.g., symbolic PECs system or iPad applications (Snodgrass et al., 2013; Meinzen-Derr et al., 2017; Meinzen-Derr et al., 2019; Shibata, et al., 2017). There were also no distinctions made between the impact of low versus high tech AAC. The research demonstrated AAC selection to be based on individual needs, e.g., a symbolic tactile modified PECs system for a child with deaf-blind disabilities (Snodgrass et al., 2013). Researchers did not believe that using AAC will hinder a child's development, so clinicians should feel supported in their implementation of AAC into therapy, while also being mindful of the limitations in the evidence (Davis et al., 2010; Meinzen-Derr et al.; 2017).

References

Coffee G. (2011) Single subject research design. In: Goldstein S., Naglieri J.A. (eds) *Encyclopedia of child behavior and development*. Springer, Boston, MA

Costantino, M. A., & Bonati, M. (2014) A scoping review of interventions to supplement spoken communication for children with limited speech or language skills. *PLOS ONE, 9(3),* 1-15.

Davis, T. N., Barnard-Brak, L., Dacus, S., & Pond, A. (2010). Aided AAC systems among individuals with hearing loss and disabilities, *Journal of Developmental and Physical Disabilities, 22,* 241-256.

Heale, R., & Twycross, A. (2018). What is a case study? *Evidence-Based Mental Health, 21(1),* 7-8. http://dx.doi.org/10.1136/eb-2017-102845

Meinzen-Derr, J., Wiley, S., McAuley, R., Smoth, L., & Grether, S. (2017). Technology-assisted language intervention for children who are deaf or hard-of-hearing; a pilot study of augmentative and alternative communication for enhancing language development. *Disability and Rehabilitation: Assistive Technology, 12(8),* 808-815.

Meinzen-Derr, J., Sheldon, R. M., Henry, S., Grether, S. M., Smith, L. E., Mays, L., Riddle, I., Altaye, M., & Wiley S. (2019). Enhancing language in children who are deaf/hard-of-hearing using augmentative and alternative communication technology strategies. *International Journal of Pediatric Otorhinolaryngology, 125,* 23-31.

Morgan, D., L., & Morgan, R. K. (2008). Multiple-baseline designs. *Single-case research methods for the behavioural and health sciences* (pp. 125-160). https://dx.doi.org/10.4135/9781483329697.n6

Murphy, K. (2010, March 8). Core vocabulary vs fringe vocabulary. Speechpathology.com. https://www.speechpathology.com/ask-the-experts/core-vocabulary-versus-fringe-vocabulary-975

Shibata, K., Hattori, A., & Matsumoto, S. (2017). "Media for capability" of children with disabilities: Development of the japanese augmentative alternative communication app by tablet for persons with hard of hearing. *Hawaii International Conference on Systems Sciences,* 3823-3828.

Snodgrass, M. R., Stoner, J. B., & Angell, M. E. (2013). Teaching conceptually referenced core vocabulary for initial augmentative and alternative communication. *Augmentative and Alternative Communication, 29(4),* 322-333.

University of Toronto Libraries: Gerstein Science Information Centre. (2020, February). *Systematic and scoping reviews: Methodologies behind the search strategies.* https://guides.library.utoronto.ca/c.php?g=588615&p=4310109