Critical Review: In children with Autism Spectrum Disorder, do high-tech devices surpass low-tech devices when evaluating increased communication skills?

Emily Currie
M.Cl.Sc (SLP) Candidate
Western University: School of Communication Sciences and Disorders

This critical review examines the evidence regarding the effectiveness of high-tech versus low-tech augmentative and alternative communication devices when evaluating increased communication skills in children with Autism Spectrum Disorder. A literature search was completed resulting in six research articles that met the inclusion criteria for this critical review. Studies evaluated included four studies using multiple baseline with embedded alternating treatment design, a meta-analysis of single case studies and a controlled case study with a single participant. Overall, the research indicates that high-tech and low-tech communication devices have a comparable rate of acquisition and effect on communication skills when working with children with autism spectrum disorder.

Introduction

Autism Spectrum Disorder (ASD) is characterized by impairments in both social interactions and communication abilities. Researchers have estimated that 50% of individuals with autism have limited or no functional speech (Boesch, Wendt, Subramanian, Hsu 2013a). This impairment impacts the individual's ability to meet daily communication needs (Chiang 2008; Koul et al 2001). In an attempt to increase an individual's ability to communicate, high-tech and low-tech augmentative and alternative communication (AAC) devices have been developed.

Due to the increased prevalence of autism over the last decade, it is important to be critical about the AAC device being chosen for an intervention for individuals with ASD. Speech-Language Pathologists (SLPs) working in the field of AAC may inquire about which type of AAC device will best yield increased communication skills with respect to time in order to maximize the effectiveness of an intervention.

To date, current research comparing the effectiveness of high-tech and low-tech devices have chosen primarily the Picture Exchange Communication System (PECS) as the low-tech device. PECS is a well researched approach that consists of six training phases. It begins by teaching the individual to exchange a picture for a tangible item, and progressively expands on language and introduces more complex communicative acts such as commenting and describing. Other forms of Picture Exchange system (PE) have been developed in which the child is taught to communicate by picking up a graphic symbol and passing it to the communication partner in exchange for the item. Unlike other PE systems, PECS has a clear set of instructional guidelines, which aids with keeping intervention universal, and consistent. In contrast to the PECS system, high-tech devices used in interventions include speech generating devices (SGD) such as a Tech/Talk, GoTalk, and Logan ProxTalker. With a SGD the learner is taught to press a picture on the device, which then produces speech output.

High-tech and low-tech AAC devices provide multiple options for intervention when working with children with ASD. These devices are meant to provide alternative methods of communication, and this critical review is addressing the comparative effects of the devices on increasing communication skills in children with ASD.

Objectives

The primary objective of this paper is to critically evaluate the existing research regarding the effectiveness of high-tech versus low-tech communication devices with regards to improving communication skills in children with ASD.

Methods

Search Strategy

Articles related to the topic of interest were found using the following computerized databases: Gale, PubMed, and Scholars Portal. Keywords used for the database search included:

> (autism spectrum disorder) AND (high-tech communicative devices) OR (speech generating devices) OR (low-tech communicative devices) AND (communication skills) OR (effectiveness)

The search was limited to articles written between the years of 2005 and 2017. Reference lists of previously searched articles were also used to obtain other relevant studies.

Selection Criteria

Studies selected for inclusion in this critical review were required to meet the following criteria: (a) participants were younger than 18 years of age (b) participants were diagnosed with ASD (including any of the pervasive developmental disorder diagnoses included in the DSM-IV-TR) (c) interventions directly compared high-tech and low-tech devices and (d) articles were available in English.

Several research articles included in this study used previous versions of the Diagnostic and Statistical Manual of Mental Disorders V (DSM - V) criteria when discussing diagnoses of autism. For the purpose of this critical review, any of the diagnoses previously used to refer to Autism Spectrum Disorder (ASD) will be referred to as the new classification of ASD.

Data Collection

This literature search yielded six articles that met the selection criteria. The studies included: four multiple baseline designs with embedded alternating treatment design, a meta-analyses and a case control study.

Results

Meta-analyses

A meta-analyses is a statistical approach that combines the results from multiple studies in order to derive conclusions about the body of research. This meta-analysis included single case studies, which are used to test the success of an intervention on a particular person and provide evidence of the effectiveness of the intervention.

Ganz et al. (2012) investigated the use of different types of AAC interventions with individuals with ASD in a meta-analysis of single case research. The study included 24 single case studies comprised of 58 individuals. The study examined the effects of AAC on communication skills and behavior of children with ASD. The comparative effects of SGD, PECS and other PE systems were also examined. Nine of the studies involved the implementation of PECS, seven involved the use of non PECS PE AAC systems, and the remaining eight studies involved SGDs. Appropriate statistical analyses were performed in order to determine the varying effects of the AAC devices as well as evaluating the differences between types of devices.

Results of the study indicate that AAC had large effects on communicative, social and academic behaviors of individuals with ASD. The greatest improvement was shown in communicative behaviors. Researchers indicated that the analyses clearly showed that AAC was an effective treatment when targeting increased communication skills in children with ASD. However, results indicate PECS and SGD were not significantly different, suggesting that both were equally effective as intervention methods to increase communication skills. The researchers also indicated that non-PECS PE AAC devices were found to have significantly lower increased communication skills than both PECS and SGD devices.

This study had several limitations, not all of the 58 individuals included in this study had a sole diagnosis of ASD, as 11 had been diagnosed with concomitant diagnoses. Studies included in the meta-analyses measured similar dependent variables in different ways, making it difficult to draw definitive conclusions about which AAC system was superior.

Overall, this study provides suggestive evidence that PECS and SGD devices were equally effective at improving communication skills in children with ASD.

Case Study Design

Case studies are used when studying a small cohort in relation to outcomes associated with a particular treatment.

Sigafoos et al. (2009) study involved a single male participant, age 15, in a controlled case study to examine a comparison between acquisition, preference and the effects on social interaction between PE and a SGD. The participant had a diagnosis of ASD, as well as a diagnosis of Down's Syndrome. The PE system used was Picture Communication Symbols and the SGD used was a Tech/Talk device. Correct use of either device was based on the child's ability to press 'want' on the SGD, or pass the 'want' PE to the communication partner while requesting a preferred object.

Results of this study indicated that the individual's acquisition rates for the PE and SGD were not significantly different. The individual showed slight preference for the PE device, although researchers claim it was influenced by relative location to the user. Social withdrawal was seen to decrease with increased use of the AAC device, when distance was manipulated.

Limitations of this study include having a small sample size, and the researchers only measuring one communicative function (i.e. requesting). Information on subject selection was limited and provided only sex, age and diagnoses. Descriptive statistics only were used while analyzing results.

Overall, this study provided suggestive evidence that a low-tech PE system is as easily acquired as the high-tech SGD for children with ASD.

Multiple Baseline Designs with Embedded Alternating Treatment Design

This design combined multiple baseline design with alternating treatment design. A multiple baseline design involves analyzing performance of individuals before and after a treatment. This does not involve a control (no treatment) condition. Alternating treatment design is used when two treatments are implemented across individuals, and progress across treatments is measured.

Son et al. (2006) compared acquisition rates of PE systems and SGDs when targeting requesting skills in children with ASD in a multiple baseline alternating treatments design. The study included two girls and one boy under the age of 6 with a diagnosis of ASD. This study compared a low-tech PE system to a Tech/Talk SGD. Data was collected at baseline and during 8 sessions for each of the children. None of the participants had used either of the devices before the start of the study. Participant inclusion criteria include: (a) being less than 6 years old, (b) diagnosis of autism or related developmental disorder, (c) lack of speech and (d) absence of any physical and/or sensory impairments that would preclude the use of either picture exchange or SGD. During intervention, both AAC options were taught and correct performance was based on the child's correct use of the device when requesting an item.

Results indicated that the children learned to request with comparable ease and speed with both the PE system and the SGD, indicating that they are both equally suitable for AAC intervention. Descriptive statistics only were provided for this study. The percentage of opportunities with a correct request across sessions, with each device was recorded and described. No further statistical analysis was performed.

Limitations of this study included small sample size, a limited number of sessions, and maintenance/generalization of these skills was not assessed at a later date.

Overall, this study provided suggestive evidence that children with ASD acquire requesting skills at similar rates using a PE system and a SGD.

Boesch et al. (2013a) study explored the comparative efficacy between a SGD and PECS on the social communicative skills and speech production in children with ASD. This multiple baseline design across participants with an embedded alternating treatment design included two boys and one girl with an ASD diagnosis, aged 6, 10, and 7, respectively. The SGD used was a Logan ProxTalker, and PECS was the low-tech communicative device chosen. Participant inclusion criteria include: (a) ASD diagnosis, (b) were between the ages of 4-12 years, (c) adequate visual and auditory perception for learning novel skills, (d) demonstrated adequate hand and eye coordination for activating the SGD, (e) had limited unaided communication skills, (f) were not current users of any speech-output technology. Baseline measures were collected for all three children using both devices. Sessions occurred 2-3 times a week over 5 months for a total of 50-70 sessions.

Appropriate statistical tests were administered to compare data sets from SGD and PECS conditions. Results revealed no significant difference between the SGD and PECS in their ability to increase communication skills. Data showed that both devices produced strong effects for all three of the participants. Another aspect that this study examined was the comparison of acquisition rates between devices, in which they found no significant difference between SGD and PECS conditions.

Limitations of this study include the small sample size, and not all participants received an equal number of training sessions. Strengths of this study was that it included three maintenance sessions eight weeks after intervention to assess the long-term effects of the use of the device. The methods were clearly described and the measures obtained were valid and reliable.

This study provided suggestive evidence that both a SGD and PECS are equally effective and easy to acquire when targeting requesting skills in children with ASD.

Boesch et al. (2013b) continued research with the same participants as in the aforementioned study to analyze the efficacy of a SGD compared to PECS in developing requesting skills in children with ASD. The SGD used in this study was the ProxTalker. Occurrence of requesting, social communicative behavior (i.e. eye contact, smiling, physical orientation), and natural speech production utterances were measured when using both devices. Data was gathered over 51-71 sessions.

Results indicated a slight increase in social communicative skills in the PECS condition, but overall both the SGD and PECS showed a comparable increase in the occurrence of requesting skills.

A limitation to this study was that researchers only followed protocol for PECS until Phase III, when research indicates speech outcome is typically only seen in Phase IV and V. This limits the outcomes of measuring speech development if they did not follow the protocol to completion. Another limitation is that not all participants had the same amount of intervention sessions. When measuring social communication behaviors researchers grouped all of the outcomes together, which creates difficulty when determining if one behavior increased more than another. Strengths of this study include having three maintenance sessions eight weeks after intervention to assess the long-term effects of the use of the device. The methods were clearly described and the measures obtained were valid and reliable.

Overall, this study is suggestive that social communicative behaviors and requesting occur equally as often with both the SGD and PECS, although the occurrence of these behaviors, as well as speech production, did not increase substantially from baseline measures.

Bock et al. (2005) implemented an alternating treatment single subject design to examine whether PECS or a SGD resulted in a more rapid acquisition rate for requesting skills. This study also analyzed the related generalization of these behaviors in a classroom setting. The SGD used in this study was the GoTalk and the low-tech system used was PECS. Participants were 6 four year-old boys in a pre-school setting. Participant inclusion criteria include: (a) children who were currently educated in a preschool setting, (b) they could physically manipulate and visually locate a laminated 2 in. x 2 in. picture, (c) they were non speaking and did not use a formal, functional means of communication. During each session, the child was given 10 opportunities or 15 minutes to use the PECS, followed by 10 opportunities or 15 minutes to use the SGD. Baseline data was obtained before the beginning of intervention.

For 3 of the 6 children, PECS was acquired at a slightly higher rate than the SGD. Once comparable acquisition of both devices was obtained, these 3 participants showed increased communicative behaviors with the SGD in comparison to the PECS. For the remaining 3 children, they had similar rates of acquisition and increased communicative functions with both devices. When assessing generalization of skill to the classroom setting, 5 of the 6 children showed a decrease in performance while using the devices compared to during the intervention setting. Appropriate statistical analyses were performed in order to determine the effects of the AAC devices as well as evaluating the differences between different types of devices.

Limitations to this study include the short duration of the study, which did not allow for training beyond Phase III of PECS and may have also affected the use of the SGD due to acquisition time. Another limitation is that the children included did not have only a diagnosis of ASD, but also had concomitant developmental disabilities. Strengths of this study include the added aspect of generalization of skills across settings. This study analyzed the use of skills acquired in intervention to the child's ability to use these skills in the classroom. Intervention protocol was very clearly described.

Results of this study are suggestive that both PECS and SGD are equally effective at increasing requesting skills. However, this study suggests that PECS requires less acquisition time and therefore allots more time for the learner to gain more complex communication skills.

Discussion

The results of the six reviewed studies provide suggestive evidence that low-tech and high-tech AAC devices are equally effective at increasing communication skills in children with ASD. Although the results of each individual study may be suggestive, they are in agreement that low-tech and high-tech devices are comparable. When evaluated as a whole the evidence is more compelling.

The effects of high-tech and low-tech communication devices with children with ASD are an important clinical question for SLPs. The evidence available provides suggestive evidence that limits the generalizability of results to a population at large. ASD represents an incredibly heterogeneous population, and it is difficult to make conclusions about the population as a whole.

It is important to consider the resulting increase in communicative skills when choosing a device for intervention with children with ASD. However, it is also important to consider several other factors that may affect the individual's success with AAC. A few advantages of low-tech devices are their low cost, maintenance and ease of portability. Advantages of high-tech devices are that they offer speech output capability, and can offer a wider variety of vocabulary words. New technology, such as the Apple iPad, may provide a solution to a more reasonable cost for a high-tech device, which is easier to transport and provides increased options for available vocabulary items. Individual differences between clients, such as level of social interaction, presence of challenging behaviors,

physical abilities and concomitant diagnoses are also factors to take into consideration.

The studies examined in this critical review are in the form of meta-analyses, case study design and multiple baseline designs with embedded alternating treatment design and present with many limitations. Limited conclusions and generalizations can be drawn due to small sample sizes, and the lack of longitudinal data assessing the maintenance following intervention. Selection criteria were impacted by the heterogeneous population and also due to comorbidities. Therefore, despite the suggestive evidence offered in the research, conclusions must be made with caution.

Future Research

Results warrant further studies with a larger population samples that also analyze the long-term effects, and look at a wider variety of communicative functions. It is recommended that further research be conducted to confirm the comparison between the low-tech and high-tech devices, considering the new development in technology with the current widespread use of iPads as AAC devices in unison with communication apps.

Clinical Implications

There is presently some knowledge about the effectiveness of high-tech versus low-tech communication devices at increasing communication skills in children with ASD, providing a suggestive level of evidence. The evidence provided by the six critically reviewed articles provide researchers with a base to continue future research. Future research will provide stronger conclusions to suggest recommendations about AAC devices when working with this population.

It is important to remember that family centered care is of importance in Speech-Language Pathology services and that ultimately it is up to the child and their family to decide which device they wish to use. In addition, clinician's previous clinical experience, family desires, financial resources, and the child's individual differences should be taken into account when making recommendations about a particular AAC device. It is important to be informed on the available research with high-tech and low-tech devices and to know that both devices are suggested to be equally effective AAC devices for children with ASD. Further research is still required to provide more compelling evidence on the effectiveness of both high-tech and low-tech communication devices.

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