Critical Review: Are high-tech devices more effective for engagement in social interactions when compared to low-tech devices for children with Autism?

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

This critical review examines the literature to explore the efficacy of a high-tech augmentative and alternative communication (AAC) device when compared to a low-tech device for children with autism to support engagement in social interactions with peers and others. A literature search was conducted using computerized databases and specific inclusion criteria. Study designs include: seven single-subject multiple-baseline designs, one single subject case study and one clinical trial. Overall, the results of this review are suggestive. Recommendations for future research and clinical practice are provided and discussed in the review.

Introduction

Autism, or Autism Spectrum Disorder (ASD), involves a range of challenges in which an individual's social and communicative functioning are often impacted. Each individual can have their own unique set of challenges and strengths based on their own profile. Currently, it is estimated that 1 in 59 children are diagnosed with ASD (Gilroy, Leader & McCleery, 2018). Of that, it is estimated that approximately 50% have limited or no functional spoken communication (Boesch, Wendt, Subramanian & Hsu, 2013b). As such, these children require intensive communication support with the introduction of Augmentative and Alternative Communication (AAC) systems to participate and communicate in everyday life.

The AAC system chosen for each child must incorporate and capitalize on their individual strengths and needs and can include aided or unaided systems, different graphic symbols as well as the decision of a high-tech or low-tech option (ASHA, 2019). High-tech options are often Speech-Generating Devices (SGDs) or Voice-Output Communication Aids (VOCAs) which can include high-end specialized devices i.e., Tobii Dynavox as well as moderately priced commercially available devices i.e., Apple iPads (Gilroy, et. al., 2018). Low-tech options can include specialized system such as the Picture-Exchange Communication Systems (PECS) or any form of clinician designed picture exchange (PE) system (Gilroy, et. al., 2018).

In Ontario, the autism program has recently undergone many changes in which the monetary funding for assessments and interventions are limited. At a time like now, it is important that we as Speech-Language Pathologists (SLPs) are ensuring that we are providing patients with service that is not only efficient but will yield the best outcomes with these limited finances.

While the AAC system should be chosen based on the individual it is also important to consider which system may have better outcomes based on their functional goals. An important communication goal to consider for these individuals is that of social participation and engagement with peers/friends, since it is an area that is often hindered and may impact their quality of life. Social interactions with others can incorporate many communicative skills including: greetings, requesting, sharing information, etiquette (smiling, eye contact), etc.

Therefore, this paper will review and evaluate the evidence on whether a low-tech picture-based system compared to a high-tech speech-generating system is more effective for engagement in social interactions for children (3-18 yrs) with autism.

Objectives

The objective of this paper is to critically evaluate the literature exploring the differences in efficacy of using a high-tech system vs. a low-tech system for engagement in social interactions for children with autism. The secondary objective is to provide evidence-based recommendations for clinicians to assist decisions on devices to suggest for these individuals.

Methods

Search Strategy
Journal articles related to the topic of interest were found using the following databases: PsychINFO, PubMed, SCOPUS as well as Google Scholar. Keywords used in search engines were as follows: ("Augmentative and Alternative Communication" OR "AAC") AND "Autism" AND "high-tech" AND compar*

Reference lists for searched articles that met criteria were also used to obtain relevant studies. The search was limited to articles written in English.

Selection Criteria

Studies selected for inclusion in this critical appraisal were required to: compare some high-tech system (i.e., SGD, VOCA) with a low-tech system (i.e., PECS, PE, etc.), include children who were formally diagnosed with autism (or ASD), and have outcome measures that were related to social interactions with peers or social communication goals (i.e., requesting with a partner, greeting, etiquette etc.).

Data Collection

Results of this literature search yielded nine articles that related to the selection criteria mentioned: clinical trial (1), single-subject case study (1), single-subject multiple baseline with alternating treatments (7).

Results

Clinical Trial Study

Gilroy, et. al., (2018) completed a clinical trial with randomization at the class level comparing use of high-tech SGD (n=17) and low-tech PECS (n= 18) in 5-13-year old children appropriately diagnosed with ASD and recruited based on school registry. Key stimuli were selected by a well-described reinforcement selection tool. Intervention was delivered by a trained and supervised student over 3 months in 15-minute sessions, although the number of sessions was not specified, and terminated at the end of the programmed school year. Outcome measures of functional communication (prompted/unprompted requests, social communication) were based on a video-recorded session using a tool developed for the study. Acceptable reliability was reported for the study tool. Interobserver agreement was calculated for all primary outcome measures and presented to be within appropriate levels. Research assistants participating were blinded to the identities of the participants and to their group assignments.

Repeated-measures analyses of variance (RM-ANOVA) was performed to evaluate differences post-intervention. Authors noted use of Bonferroni correction to reduce likelihood of Type I error. These appropriate statistical analyses revealed a significant improvement for all measures pre to post therapy, however no significant interactions were reported.

Limitations included: classroom level randomization (as opposed to complete randomization of participants), lack of reported treatment integrity protocol, and short length of study (only 3 months). Nonetheless, the measures used were reliable, and the study applied

suitable statistics to analyze pre/post changes. Overall, this study provides compelling evidence that both high and low tech AAC devices have a significant positive effect on communication of school age children with ASD.

Multiple Baseline Design

Boesch, et. al., (2013a) used a multiple baseline design (with multiple participants and alternating treatment design) to investigate improvements in social communication behaviour and natural speech production using a low-tech PECS and a high-tech SGD in 3 school age children (6-10 yrs) diagnosed with autism using a gold standard measure. Intervention sessions (15 minutes) were completed 2-3 times a week over 5 months in the speech clinic (n=2) or at participant's home (n=1). Three graduate students with PECS training and experience working with autism completed all six phases of the intervention. Outcomes measures of social communicative behaviour included occurrences of eye contact, physical orientation and smiling in response to a presented stimulus and counted by trained observers from session recordings.

Data analysis involved visual analysis of level, trend, variability, overlap and immediacy of effect of intervention as well as an index of data overlap (NAP index). Results were inconsistent, with some indication of increased social communication in some study phases, but overall no differences based on communicative system were evident.

Limitations of this study included: the small sample size (n=3), the different session environments (one at home), and the variable number of sessions. In addition, they were using a structured PECS protocol with both the low-tech and high-tech system of which they only reached phases I through III. However, they noted that phases IV and V are designed to increase language skills, therefore their outcomes may be limited by only reaching the first 3 phases. Still, the study did include three maintenance sessions eight weeks after follow-up of intervention which looked at the long-term effects of the use of the device as well as included interobserver agreement and procedural integrity. Overall, this study provides highly suggestive evidence that there is no difference between providing either a low-tech PECS or a high-tech SGD for increasing social communication behaviours for children with ASD.

Boesch et. al. (2013b) is an extension of the study listed above using the same participants and multiple baseline design with alternating treatment to compare the efficacy of using a low-tech PECS compared to a high-

tech SGD to develop requesting skills and improve functional communication.

Appropriate statistical tests (Wilcoxon Signed Pair Test) as well as similar visual analysis to above study (including level, trend, variability, overlap and immediacy of effect) were used to examine data from both conditions. Results revealed no significant differences between intervention conditions (SGD or PECS) in any phase for increasing requesting and functional communication.

Limitations to the study included: variable number of sessions, small sample size (n=3) and only testing one communicative function (requesting). The study was also conducted in a highly structured environment for 2 of the participants, therefore differences in communication may be noted if they had been in a more naturalistic environment. However, the study included a similar maintenance period to their previous study, as well as interobserver agreement and treatment integrity protocols. Therefore, this study provides suggestive evidence that both PECS and SGDs can be used to increase requesting skills in children with ASD and that neither provides additional benefits.

Son, Sigafoos, O'Reilly & Lancioni, (2006) investigated the acquisition rate for a requesting response using either a low-tech picture-exchange (PE) method or a VOCA on three children (3-5 yrs) with autism (n=2) or pervasive developmental disorder (n=1) using a multiple baseline alternating treatment design. All three children were selected through author-based inclusion criteria and on attendance in a pre-school program where the author volunteered. Intervention was focused on the child using either system to request a preferred snack at home with a trainer during sessions (10-minutes in length) until they reached 75% accuracy although the number of sessions varied for each child. Sessions were videotaped and later coded by independent observers to assess reliability (percentages were within range of acceptability). The study's outcome measures were based on both AAC options with regard to the percentage of opportunities with correct requesting.

Data analysis involved calculating percentage of opportunities with correct request for each device; no other statistical analysis was performed. Results indicated that there was little/no difference between either system for all the children (slope, level and trend on the graphs were all comparable). One child was noted to acquire the VOCA system more rapidly. However, all of the children were able to learn both systems and use them for requesting.

Limitations of the study included: no maintenance period, variable number of sessions based on the family's availability, and participants were chosen based on author's selection. Nevertheless, this study provides suggestive evidence that both systems are viable AAC options with regards to acquisition of requesting skills in children with autism.

Agius & Vance, (2016) completed a multiple baseline with adapted alternating design with three children (3-4 yrs) with a diagnosis of ASD (by psychologist) looking the relative efficacy of the iPad with PECS for developing requesting and navigational skills. The sessions (20-min duration) were carried out in an intervention room by two researchers over the course of 8-weeks (4 per each condition, or 6 sessions). Outcome measures were looking at requesting as the main variable only. Authors noted interobserver agreement, treatment integrity and social validity for the study which were all within acceptable ranges.

Data analysis was provided by calculating percentage of independent requests as a percentage of all trials to criterion formula [(independent requests/(independent requests + prompted requests) x 100%] as well as visual comparison of level, trend, and variability across each study phase with figures. Results demonstrated that the participants were able to acquire both AAC options for requesting, and that they were equally effective with regard to acquisition speed. In addition, they found that there was a lack of clear preference for each system and that all the participants were able to learn complex navigation on the high-tech iPad.

Limitations of the study included: a small sample size (n=3), all participants were high performers on IQ tests (which reduces generalizability to more severely impaired individuals) and the sole focus on one communicative function (requesting). On a positive note, follow-up was completed to assess maintenance. Overall, the study provides highly suggestive evidence that both AAC options can be used to teach requesting skills with comparable acquisition speed.

Van der Meer, Sutherland, O'Reilly, Lancioni & Sigafoos, (2012) study involved four children (4-11 yrs) diagnosed with autism in a multiple-baseline alternating design to compare: acquisition of requesting with three different AAC modes: SGD, PECS, and manual signing (MS), whether participants preferred one method over another, and whether that preference would affect their acquisition rates. Three students received intervention at home (with parent as trainer) and one received intervention at school (with a special education teacher as trainer). Intervention sessions consisted of requesting preferred items (toys or snacks) and were completed 3-5

days per week although duration was not specified. During intervention, AAC options were taught until the child reached criterion (80%), correct performance was based on the child's correct use of system or signing when requesting an item.

Data analysis for the study included calculating percentage of correct requests during each session only. Results were positive for all students being able to request using at least one of the three AAC options, although MS was the least preferred and had the slowest acquisition rate. Post-intervention the children's preference had changed (from baseline) demonstrating that learning impacted their preference.

Limitations of the study included: that each trainer was different for each specific child (not consistent), small sample size (n=4), and a sole focus on one communicative function (requesting). However, the study did include interobserver agreement measures, procedural integrity, as well as a maintenance period (8 weeks post-intervention). Overall, this study provides somewhat suggestive evidence that both SGDs and PECS can be acquired with similar rates and ease and that children may show a preference for them once they have been taught.

Van der Meer et. al., (2013) is an extension of the aforementioned study using two of the same participants (n=2) in a multiple baseline with alternating treatment design to investigate if each participant could learn more complex communication skills (beyond requesting) with each AAC system (SGD, PECS, MS) and if their preference would remain stable with the introduction of these higher skills. Intervention sessions were conducted by parent or author and ranged from 2-5 days per week although duration was not specified. Outcome measures for the study included independent use of the communication system for: two and three-step requests (for play/food), greetings, answering questions and etiquette.

Visual data analysis involved calculating percentage of correct requests during each session Results revealed that all systems (SGD, MS, PECS) were moderately successful at teaching complex social skills and that the child's preference for each system did not change with the increased complexity.

Limitations to the study included: short baseline period, modification of procedure for one participant due to difficulty attaining goals, two different instructors for each participant and a very small sample size (n=2). Overall, this study provides somewhat suggestive evidence that all three systems (SGD, MS, PECS) can be used to increase complex social communicative skills

in children with ASD and that preference is a contributing factor to use of the system in this context.

Flores et. al., (2012) examined the effectiveness of using a high-tech Apple iPad compared to a low-tech picture-based system for requesting in five students (ages 8-11 yrs) with disabilities (n=3 with ASD) who all had IEP goals related to language and communication. Intervention was provided during snack time at a university-sponsored summer program that lasted 5 weeks (sessions were 2 hours after regular meal times) in classrooms with 3-4 other peers with needs led by graduate and undergraduate students. Independent observers counted the frequency of communication behaviours in each session using video recordings, which was noted as their outcome measures. Acceptable interobserver agreement and treatment integrity were reported.

Data analysis involved visual analysis of results by authors who noted differences in frequency of communicative behaviours by comparing data paths of figures. Results were mixed; one student showing greater interactions with iPad, but there were no clear patterns across all students.

Limitations of this study included provision of intervention during a summer program instead of a more naturalistic setting, length of study (only 5 weeks), and only targeting one communicative function (requesting). Overall, this study provides suggestive evidence that high-tech and low-tech devices are comparable with no clear superiority of one over the other.

Single-Subject (n=1) Case Study
Sigafoos et. al., (2009) completed a single-subject (n=1) controlled case study with a 15-year old student diagnosed with autism using a gold-standard measure, to compare acquisition, preference, and effects on social interaction between PE and SGD. Intervention was delivered by a trainer 2-3 days per week (5-minute sessions) for 8 weeks at a table in the classroom in the context of a snack activity based on a detailed preference assessment. Outcome measures for the study included correct requesting with either system and duration (secs) of social withdrawals during interactions which were recorded and counted by a trainer and an independent observer. Acceptable interobserver agreement and treatment integrity were reported.

Data analysis involved calculating the number of instances of correct requesting as well as the duration (in seconds) of social withdrawal presented in figures. Results from study 1 indicated that the student was able to acquire both systems equally (no significant differences noted) but that neither intervention was

significant at reducing social withdrawal. Study 2 demonstrated that the student had a slight preference for the PE system however, authors claimed that this may have been due to relative location of the system and not a distinct preference. Lastly, study 3 described how a distancing manipulation was associated with a decrease in social withdrawal, however only the PE system was used.

Limitations of the study included: that it was a case study (n=1) and only targeted one communicative function (requesting). In addition, only the PE system was used in the last section of the study. Regardless, this study provides suggestive evidence that the acquisition rate of both systems (PE and SGD) is equivalent.

Discussion

This review analyzed nine studies to determine whether a low-tech picture-based system was more effective when compared to a high-tech speech-generating system for engagement in social interactions in children (3-18 yrs) with autism. There was some variation with the studies in regard to what the social engagement measures was determined to be including:

- Functional communication i.e., unprompted requests, queried requests, and social communication as intra-verbal tracts (Gilroy et. al., 2018),
- Social communicative behaviour i.e., eye contact, physical orientation, and smiling before and after reinforcer presentation (Boesch et. al., 2013a),
- Requesting (Boesch et. al., 2013b, Son et. al., 2006, Agius et. al., 2016, Van der Meer et. al., 2012, Flores et. al., 2012),
- Multiple communicative functions i.e., two and three step requests, greetings, answering questions, and etiquette (Van der Meer et. al., 2013),
- Food requests and duration of social withdrawals (Sigafoos et. al., 2009).

However, the relative consistency of the findings in the review are more compelling given the range of ages and intervention presentations in the studies. When evaluated as a whole, they provide compelling evidence that low-tech and high-tech systems are comparable and may both be considered as treatment options.

While the evidence is demonstrating that both systems are comparable with regards to increasing social engagement for children with autism, it is important to also reflect on other factors that may be considered when choosing a device. For example; low-tech devices are more cost-efficient as they can be developed and

provided to the client directly from the SLP without a large budget. In addition, they may be easier to use for clients who are more developmentally challenged and/or have physical/visual difficulties which may limit their ability to interact with a high-tech device. On the other hand, high-tech devices offer speech output which may be more advantageous when attempting to interact with a peer or communicative partner. However, they can be costly and require regular maintenance and care. These factors, in addition to the clinician's clinical expertise and evaluation of the client, need to be considered along with the provided literature review to deliver best outcomes for clients.

Overall, limited conclusions and generalizations can be made due to all the studies small sample sizes and lack of consistent social communication measures. Furthermore, individuals presented in the studies differed in their severity level and age. Therefore, despite consistent suggestive evidence that provides an overall compelling argument, clinical implications with regard to the review must be tentative.

Clinical Implications

The evidence reviewed supports the use of either low-tech or high-tech as potential AAC systems for children with autism for social engagement. Studies presented in this review demonstrate that both systems are equally effective as potential options for SLPs to consider with clients. It is important that SLPs do not forget to first determine the client's strengths, needs and finances when making recommendations for a specific AAC device. Because of the technological advances and easy access to commercialized devices it is imperative that future research continue to determine which new high-tech devices are equally effective to previous devices or low-tech options. In addition, as social interaction measures were consistently variable in each study, it is vital that studies look at multiple aspects of social interaction including: commenting, information-sharing etc. with age-matched peers. Specifically, future research should compare the use of a low-tech picture-based system vs. a high-tech speech-generating system for children (aged 3-18 yrs) with autism for appropriate social peer-to-peer interactions.

References

American Speech and Hearing Association. (2019). Augmentative and Alternative Communication. Retrieved from: https://www.asha.org/PRPSpecificTopic.aspx?folderid=8589942773&section=Overview

Agius, M. M., & Vance, M. (2016). A comparison of PECS and iPad to teach requesting to preschoolers with Autistic Spectrum Disorders. Augmentative and Alternative Communication, 32(1), 58-68.

Boesch, M.C., Wendt, O., Subramanian, A., & Hsu, N. (2013a) Comparative Efficacy of the Picture Exchange Communication System (PECS) versus a Speech-Generating Device: Effects on Social-communicative Skills and Speech Development, Augmentative and Alternative Communication, 29:3, 197-209.

Boesch, M. C., Wendt, O., Subramanian, A., & Hsu, N. (2013b). Comparative efficacy of the Picture Exchange Communication System (PECS) versus a speech-generating device: Effects on requesting skills. Research in Autism Spectrum Disorders, 7(3), 480-493.

Flores, M., Musgrove, K., Renner, S., Hinton, V., Strozier, S., Franklin, S., & Hil, D. (2012) A Comparison of Communication Using the Apple iPad and a Picture-based System, Augmentative and Alternative Communication, 28:2, 74-84.

Gilroy, S. P., Leader, G., & McCleery, J. P. (2018). A pilot community-based randomized comparison of speech generating devices and the picture exchange communication system for children diagnosed with autism spectrum disorder. Autism Research, 11(12), 1701-1711.

Sigafoos, J., Green, V. A., Payne, D., Son, S. H., O'Reilly, M., & Lancioni, G. E. (2009). A comparison of picture exchange and speech-generating devices: Acquisition, preference, and effects on social interaction. Augmentative and Alternative Communication, 25(2), 99-109.

Son, S. H., Sigafoos, J., O'Reilly, M., & Lancioni, G. E. (2006). Comparing two types of augmentative and alternative communication systems for children with autism. Pediatric Rehabilitation, 9(4), 389-395.

Van der Meer, L., Sutherland, D., O'Reilly, M. F., Lancioni, G. E., & Sigafoos, J. (2012). A further comparison of manual signing, picture exchange, and speech-generating devices as communication modes for children with autism spectrum disorders. Research in Autism Spectrum Disorders, 6(4), 1247-1257.

Van der Meer, L., Kagohara, D., Roche, L., Sutherland, D., Balandin, S., Green, V.A., O'Reilly, M.F., Lancioni, G. E., Marschik, P.B., & Sigafoos, J. (2013) Teaching Multi-Step Requesting and Social Communication to Two Children with Autism Spectrum Disorders with Three AAC Options, Augmentative and Alternative Communication, 29:3, 222-234.