

Critical Review:
Speech-generating devices and picture-based systems: Which method is more effective at increasing requesting skills in children with autism spectrum disorders?

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This critical review examines the current literature that compares speech-generating devices to picture based systems to determine which is more effective at increasing requesting skills for children with autism spectrum disorders. Six studies are reviewed, totaling 29 children (ages 3-12) with autism and other developmental disorders. The research included various single subject experimental designs. Overall, the results are inconclusive. Both methods are successful in increasing requesting skills, but there is not consistent evidence that one is more effective.

Introduction

Autism Spectrum Disorder (ASD) is a neuro-developmental disorder that includes a variety of symptoms and deficits along a continuum (Lauritsen, 2013; Sigafos, O'Reilly, Lancioni, & Sutherland, 2014). A diagnosis of Autism, according to the DSM-IV criteria set out by the American Psychiatry Association (2000), is based on a certain number of characteristics (at least six) from three categories (Mattila et al., 2011). Characteristics fall under the domains of impaired social interactions, restricted or repetitive behaviors, and communication impairments (Mattila et al., 2011). Several authors report a significant percentage (25-61%) of those with ASD that have limited functional communication abilities (Boesch, Wendt, Subramanian, & Hsu, 2013; Ganz, Hong, & Goodwyn, 2013; Lorah, Tincani, Dodge, Gilroy, Hickey and Hantula, 2013; Sigafos et al., 2014; van der Meer, Sutherland, O'Reilly, Lancioni & Sigafos, 2012). Requesting skills are an example of early functional communication abilities (Boesch et al., 2013). The diagnosis of ASD occurs in approximately one in every 88 children and can co-occur with several other disabilities and impairments (Sigafos et al., 2014).

Augmentative and alternative communication (AAC) is an available option for those with 'complex communication needs' (Boesch et al., 2012; Ganz et al., 2013; Sigafos et al., 2014). AAC is generally divided into two broad categories; aided – strategies requiring the external use of materials or equipment, and unaided – those that do not require additional or external components (Beukelman & Mirenda, 2005). Those with ASD often demonstrate impairments in communication, and are prime candidates to benefit from AAC (Couper et al., 2014; Flores et al., 2012; Ganz et al., 2013; van der Meer et al., 2013, van der Meer et al., 2012). Several AAC options have been

investigated for the ASD and developmental disability population, including picture exchange systems (PE), speech-generating devices (SGD) and manual signing (MS) (Achmadi et al., 2012; Boesch et al., 2012; Couper et al., 2014; Flores et al., 2012; Ganz et al., 2013; Lorah et al., 2013; van der Meer et al., 2013, van der Meer et al., 2012).

A review of the literature indicates that there are mixed results and much debate as to which AAC method is most appropriate for children with ASD (Lorah et al. 2013; Sigafos, 2014). Frequently used, PE systems have been reported to increase functional communication skills in children with ASD (Boesch et al., 2012; Flores et al., 2012; Ganz et al., 2013). The emergence of new technology in the form of tablets and other electronic devices, now capable of offering speech-generating applications, is expanding the possibilities for communication tools, and receiving a high degree of media attention (Achmadi et al., 2012; Flores et al. 2012; Ganz et al., 2013; Lorah et al., 2013; McNaughton and Light, 2013; Sigafos et al. 2014). Some propose that there are more benefits of SGDs in comparison to PE systems (Boesch et al., 2012). For this reason, speech-language pathologists need to be educated on the effectiveness and benefits of both SGDs and PE systems for children with ASD so they make sound evidence-based decisions when selecting a method.

Objective

The objective of this paper is to critically review current research that compared PE systems to SGDs to determine if one method is more effective at increasing requesting skills for children with ASD.

Methods

Search Strategy

Articles were found using computer-based databases through the Western University Library. Searched databases included: PubMed, Google Scholar, ProQuest, Scopus, Scholars Portal and PsycINFO. Search terms were: (Autism Spectrum Disorder) or (Autism) or (ASD) and (AAC) or (Speech Generating Device) or (SGD) and (Requesting). Additional references in acquired articles were also included.

Selection Criteria

Studies were included when participants were children with a diagnosis of ASD, an outcome measure of requesting skills was reported, and regarded both PE systems and SGDs. No limitations were placed on the research design. This topic is current with emerging literature; articles were recent publications dated after 2011. One study, van der Meer et al. 2013, was excluded as it investigated multi-step requesting, a more advanced skill.

Data Collection

The search for research studies consistent with the selection criteria returned six single subject experimental designs, including: A-B-A-B-A, multiple-baseline across participants with alternating treatment (3), multiple-baseline across-participants with concurrent baseline control, and randomized alternating treatment presented with initial baseline.

Evidence was evaluated using a scale developed for single-subject research designs by Logan, Hickman, Harris, and Heriza (2008). The highest level of evidence is level I, the lowest is level V.

Results

Boesch, Wendt, Subramanian, and Hsu (2013) compared the use of a 5-button SGD ('ProxTalker'), to the Picture Exchange Communication System (PECS; Bondy & Frost, 1994) in a multiple-baseline across-participants design with alternating treatment (level I evidence) to develop requesting skills. Participants were three children (ages 6-10) with an appropriately verified diagnosis of ASD, limited or no functional communication skills according to a suitable inventory, currently not using an SGD, and had various levels of experience with picture-based systems (not PECS).

The study included: a stimulus preference assessment (to identify high interest target items), baseline (reinforcer paired with label), PECS condition (traditional protocol), SGD condition (modified PECS protocol), follow-up, and maintenance 8 weeks later. The two conditions included the following phases: I) physical exchange, II) distance and persistence and III) discrimination, which were progressed through based on mastery of criterion (80% accuracy with 3 items across 2 partners for 2 consecutive sessions). Three individuals with PECS training were the communication partners. Sessions took place in a therapy room (n=2) and at a home (n=1). Food items were requested.

Data was first analyzed visually. Appropriate Wilcoxon signed pair tests (Wilcoxon, 1945) comparing requests in the use of PECS and an SGD revealed no significant differences in any phase of intervention for any participants (similar levels of requesting). Effect size was calculated using an appropriate non-overlap of all pairs calculation, in which high percentages reflect low overlap (NAP; Parker & Vannest, 2009). The NAP scores were reported between 94-100% (strong effect) for PECS and 88-100% (medium-strong effect) for SGD across all participants. Two independent observers looked at the occurrence of techniques in each phase via recordings of 1/3 of the sessions. Interobserver agreement was 99-100% while treatment integrity measured at least 94%.

The study was well formulated with appropriate methods and valid statistical manipulations. The use of a measure of effect size is creditable; however, the NAP calculation shows an effect while the Wilcoxon test did not. This may be because the Wilcoxon test looked at all phases of intervention while the NAP only compared baseline to one phase. The use of a follow-up condition was good to include, confirming one condition did not affect the other, but it was

completed with the condition that “yielded more favorable results” even though there were no statistically significant differences according to the Wilcoxon test. Additional considerations included a small sample size, a participant with a diverse cultural background and various levels of experience with picture-based systems prior to this study.

Overall, Boesch et al. (2013) provides suggestive evidence for the equal effectiveness of both SGDs and picture-based systems for enhancing requesting skills in children with ASD. It is relevant to future research involving SGDs and PECS and applicable to clinical practice when considering which method to recommend.

Couper et al. (2014) evaluated the number of requests made with three AAC methods (SGD - Apple iPod Touch® /iPad® with Proloquo2Go™ software, a PE system, and MS (New Zealand Sign Language) in a non-concurrent multiple-baseline across participants with alternating-treatments design (level I evidence). Participants were nine children (ages 4–12) with ASD including one with a dual diagnosis of Down syndrome. The children had limited or no expressive language skills based on an appropriate measure, and various levels of previous experience with both picture systems and SGDs.

The children participated in 5 trials per session at baseline (all three methods present to indicate want, no prompt to use AAC), 5 trials per session at intervention (one method at a time, wait 10 seconds for request and then prompt to use AAC, immediate reinforcement), post-teaching (once criterion was achieved, all three methods present), and follow-up 3-10 weeks later (no prompts). Intervention with each method was continued until at least 80% accuracy was achieved across three consecutive sessions. Five experienced individuals were trained for intervention. Sessions took place at school (n=3), home (n=5) and a clinic room (n=1). Preferred toys were requested.

Figures for each participant were visually analyzed to describe results. No statistical calculations were reported. Inter-observer agreement between one independent observer and the instructor based on the number of correct requests trial-by-trial ranged from 36-100% (mean = 88%). Procedural integrity was reported between 52-100% (mean = 89%); the independent observer assessed whether the instructor followed the intervention procedure order accurately.

Numerous procedural modifications were made for several of the children during the intervention phases, which may have compromised the integrity of the

experimental design. Diverse participants (age, previous experience, different abilities), variety of session locations, as well as withdrawal by one of the participants is also important to note. Additionally, reported challenging behaviours may have impacted results. Significant weaknesses of this study included no statistical measurements and the wide ranges reported in the inter-observer agreement and procedural integrity. These ranges may have been due to the variety of individuals serving as the instructor. One instructor was reported to be that child’s family member. The instructors were not blind to the study; in fact, they were given “explanation of the study aims and procedures”(p.2) which raises some question of reliability and validity.

This study concluded that all three options (SGD, PS, MS) were successful AAC methods for children with ASD to use to request based on visual analysis from baseline to intervention; however, one of the participants (not including the one that was withdrawn) did not achieve criterion with any method. Overall, Couper et al. (2014) provides equivocal evidence on its validity and importance due to the number of concerns addressed above. Caution should be exercised when considering this information for further research and clinical practice.

Flores et al. (2012) investigated the frequency of requesting in five children (ages 8-11) with disabilities, three with an ASD diagnosis. The children had limited verbal communication skills based on two appropriate assessment measures and were all skilled users of picture systems. An A-B-A-B-A design (level IV evidence) was used to compare the students’ current PE system (A) to the SGD (Apple iPad® with “Pick a Word” software) (B).

This study was run as part of a five-week summer program in a school and sessions were conducted in the snack room. Food items were requested. There were four symbols of the preferred snack and two requests “I want” and “more” in both conditions. The teacher initiated the sessions by asking the students which snack they wanted and would provide a small amount to allow for the opportunity to request “more”. Students were initially given practice sessions with instructions and prompts on how to use the iPad® as it was new.

No statistical calculations were reported. Results were analyzed visually. Doctoral students in special education watched recorded sessions that were compared with a teacher who was tracking live in the session. Interobserver agreement was 86-96% (mean = 91%) across ¼ of the sessions. Treatment integrity,

involved an eight item checklist by observers, was reported at 100% across all sessions.

This study had excellent treatment integrity. Limitations included the time constraint of the five-week program and the limited amount of time for the session (15 minutes) that did not allow for sufficient data collection (2-5 data points for each phase). Another consideration when evaluating this evidence is that these five participants were skilled users of their personal and familiar picture-based systems, so they were already successful with requesting. Lastly, it is important to note only three of the five participants in this study actually had a diagnosis of ASD, which impacts the ability to extend the results to the targeted population.

Flores et al. (2012) concluded that there was no clear pattern for increased requesting skills between the two methods. Some students had a visual increase with the SGD condition; others remained at the same frequency as the picture-based condition. Overall, this research is suggestive that SGDs (specifically iPads®) may be an effective method for increasing requesting skills. At the very least, the use of the iPad® does not take away communication skills and can be considered in clinical practice as an option for children with ASD.

Ganz, Hong, and Goodwyn (2013) conducted a multiple-baseline across-participants with concurrent baseline control study (level II evidence) to determine whether a PECS app on the iPad® (used as an SGD) was as effective as traditional PECS (Bondy & Frost, 1994) for three preschoolers (ages 3-4) with either an ASD or pervasive developmental disorder-not-otherwise specified (PDD-NOS) (n=1) diagnosis. The children had 'complex communication needs' determined by an appropriate rating scale and had mastery of PECS Phase IIIB or IV.

The study included a preference assessment (to determine stimuli) baseline (performance with PECS and the PECS App on mute), six app instruction sessions (taught how to use the App with the sound on), and a post-intervention choice phase (both options available). Sessions took place during a summer session in a therapy room at an autism clinic. Preferred toys and snacks were requested.

Data was analyzed both visually and with an appropriate statistical analysis measure. Effect size was determined using a Tau-U analysis (Parker, Vannest, Davis, & Sauber, 2011), which revealed statistically significant differences for two of the children from baseline to post-instruction choice

phase. Confidence intervals were set at 90%. Two of the three participants significantly increased their independent, correct use of the App, while the third participant's results were not statistically significant. Two raters observed all of the sessions and determined inter-rater agreement, indicating precision in procedures. Appropriate treatment fidelity checks by two observers using a checklist were also reported for participants (range 95.24-98%).

This study demonstrated a sound research design, included statistical analysis of the data, and provided high ratings of both reliability and validity. A limitation was that there was no follow-up phase due to the time constraint of the summer program so it is unknown whether the results were maintained. It should also be cautioned that the few participants in this study not only had prior experience with a picture-based system but were already proficient users of PECS. Results indicated that all of these children were able to use the PECS app to successfully make requests. While there was a statistically significant increase from baseline in use of the App, it was not consistent across all three participants. It was proposed by the authors that the third participant did not show a significant increase due to being at a more complex phase of PECS (IV).

Overall, Ganz et al. (2013) provides compelling evidence that the iPad® with PECS app can be used as an effective method for increasing correct and independent requesting skills in children with ASD.

Lorah et al. (2013) evaluated five preschoolers (ages 3 – 5) with a diagnosis of Autism in an alternating treatment presented in random order with initial baseline design (level I evidence) that compared PE systems to an SGD (Apple iPad® with Proloqu2Go™). The frequency of independent and prompted requests (mands) was evaluated. The children did not have experience with formal mand training, PE or SGD prior to the study and had weak - absent scores on an appropriate assessment measure. All participants had been receiving group and/or individual speech therapy.

The procedures included a stimulus preference assessment (to determine reinforcement items), 10-15 baseline trials (both AAC options available no prompts), 15 trials of mand training (physical prompts to use the PE book or iPad®), and maintenance sessions (no prompts). Three experimenters were experienced with training on data collection and prompting. Sessions were completed in a classroom. Unspecified items were requested.

No statistical analyses were reported, data was analyzed visually. Interobserver agreement was based on less than half of the training sessions but included all baseline sessions. Procedural reliability was determined using a checklist for all sessions. Both measures were reported at 100%.

This study had a valid research question and the dependent measures were well defined. The design of the study was appropriate, with excellent interobserver agreement and procedural reliability; however, there was no reported statistical analysis meaning these results need to be interpreted with caution. A major limitation of this study was that participants did not have to discriminate their selection from an array, as they only had to select one picture at a time. This is problematic because it does not demonstrate the ability to request from a variety of desired items. The authors also reported concern over possible carry-over effects as both conditions were trained in the same day.

Both the PE system and the SGD increased from baseline for all participants. Higher rates of independent requesting were observed in four of the five children with the SGD relative to baseline. Overall, Lorah et al. (2013) contributes suggestive information that SGDs may be more effective than picture based systems at increasing requesting skills in children with ASD.

van der Meer, Sutherland, O'Reilly, Lancioni, and Sigafos (2012) evaluated the independent and correct use of requesting skills using three methods (SGD - Apple iPod Touch® / iPad® with Proloquo2Go™ software, PE system, and MS - Makaton Sign Language System) in an alternating treatment, non-concurrent multiple baseline across participants design (level I evidence). Participants were four children (ages 4-11) with a diagnosis of ASD; however, several of the children had additional diagnoses. The children had limited or no expressive language skills based on an appropriate measure, and one had previous experience and/or training with both picture systems and SGDs.

This study involved preference assessments (conducted pre-baseline and then after every baseline, intervention and follow-up session), baseline (preferred items in view, AAC options available), intervention ("let me know if you want this" with graduated guidance to prompt using each of the methods), and nine follow-up sessions three-eight weeks later. Baseline and intervention sessions had 12 trials per session (three trials/item) and counterbalanced the order of AAC methods. Criterion

was set for the intervention phase at 80% correct requesting with each method across three consecutive sessions. The trainer was the child's mother (n=3) or teaching assistant (n=1). Sessions occurred at the family home (n=3) and in the classroom (n=1). Snacks and/or toys were requested.

Results were reported in figures and charts and analyzed visually. No statistical analyses were reported. Interobserver agreement between the trainers and an independent observer was 95-99.7% for the 1/3 of the study while procedural integrity was reported at 98.8-99.9% using a checklist completed by the independent observer. A second independent observer completed integrity checks on an additional 11% of the data with 100% agreement.

The variables and methodology were well defined and the design was appropriate. Only one of the four participants in this study had an exclusive diagnosis of ASD. Procedural modifications were also made for that one participant with a sole ASD diagnosis in order to progress through the intervention. Also, this study used familiar trainers (mothers and teaching assistant but rationalized it as part of their research question to determine whether important partners could successfully implement intervention procedures in familiar environments.

Three of the four participants were able to achieve proficiency in using the SGD for requesting. There was a visual increase from baseline for both conditions. Overall, van der Meer et al. (2012) provides suggestive evidence that both SGDs and picture-based systems are effective at increasing requesting skills in children with ASD. It is applicable to clinical practice because this study showed individual differences for which system demonstrated more requesting skills highlighting the importance of considering the individual and their abilities when selecting an AAC method.

Discussion

The reviewed recent single subject experimental design studies provide evidence that both picture-based systems and SGD's are effective options for increasing requesting skills in children with ASD. While one method does not consistently prevail, there is evidence to support the use of both systems in clinical practice. Additional considerations of the child with ASD and their abilities, family preference, and additional advantages/disadvantages of both systems should be discussed.

Most of the studies included the emergence of new technology, specifically the iPod® /iPad® as an SGD. It was noted to be successful at facilitating requesting skills in several of the studies (Couper et al., 2014; Flores et al., 2012; Ganz et al., 2013; van der Meer et al., 2012). At the very least, the use of this new technology does not take away communicative skills and can be considered in clinical practice as an option for children with ASD and other developmental disorders. Further research with various applications is warranted.

The research included in this review had several limitations. One of the most obvious was the small sample sizes (less than 10 participants) and the inclusion of participants with other diagnoses. This impacts the generalizability of the results; however this is the true nature of a heterogeneous population such as ASD. This review looked at children with ASD, but that encompassed both preschoolers and school age where skill sets and understanding may be at different levels. The lack of statistical measures used in all of the studies except Boesch et al. (2013) and Ganz et al. (2013) also make it difficult to determine whether the results are significant. Also, several modifications were made in some of the studies, which alter their reliability and validity but the designs of multiple-baseline across participants and alternating treatment are appropriate and good for increasing validity. Most of the studies (except Couper et al., 2014) reported high rates of interobserver agreement and procedural integrity. Various experience with SGDs and PE systems prior to the study are problematic as it may bias results.

Conclusion

Overall, the comparison of the two AAC methods did not yield one method as more advantageous than the other for increasing requesting skills in children with ASD. It can be concluded that both options are effective and can be considered in clinical practice. This evidence on whole can be described as suggestive. It provides important information to this area of research, but the validity of the evidence can be debated. Further research is needed to determine if one method is clearly superior to the other. Considerations for additional research should include impact of previous experience, additional diagnoses, controlled environment with consistency in requested items, and the use of statistical tests.

Notes: Apple iPod Touch® and Apple iPad® are registered trademarks of the Apple Corporation, Cupertino California, Proloquo2Go® is a registered trademark of AssistiveWare B.V., Amsterdam the Netherlands.

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