Critical Review:
Are speech-generating devices an effective way to teach children with autism new communicative skills?

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This critical review examines whether speech-generating devices are effective in teaching children with autism new communicative skills. Seven studies are reviewed here totalling eight children with autism. Study designs include single subject ABAB, multiple baseline across participants (3), multiple baseline across settings, narrative review, and literature review. Results of the studies reviewed provide suggestive evidence for the use of speech-generating devices to teach children with autism requesting skills. Recommendations for future research and clinical implications are discussed.

Introduction

Autism is a spectrum disorder characterized by deficits in social skills and language and the presence of restrictive and repetitive interests (American Psychiatric Association [APA], 2000). One third to one half of children and adults with autism do not use speech functionally (National Research Council, 2001). Therefore, augmentative and alternative communication (AAC) is often a viable option.

AAC is categorized into unaided and aided forms (Mirenda, 2009). Unaided forms include signs and gestures and any other forms that do not require anything separate from the body to communicate. Conversely, aided forms include pictures (e.g., the Picture Exchange Communication System [PECS]; Bondy & Frost, 1994) and devices; i.e., something external to the body is required to communicate.

Speech-generating devices (SGDs), also known as voice output communication aids (VOCAs), have been used with children with autism since the 1970s (Ogletree & Harn, 2001). Recently, there has been an increased use of media devices such as the iPod Touch and iPad as SGDs (Gosnell, 2011). These devices have the benefits of being portable, relatively inexpensive, and easily adaptable for different situations for children with autism (Achmadi, 2010).

One particular SGD on the iPod Touch is an application called Proloquo2Go (Sennott & Bowker, 2009). This program has received increased attention in the media and literature recently. Studies on this program have demonstrated efficacy in teaching children with autism to make requests and use the device (Achmadi, 2010; Kagohara et al., 2010). However, this research is limited in that it has not evaluated the utility of this device for teaching more advanced communicative skills such as commenting, thus limiting the functions of language that are available to the children who use the devices (van der Meer & Rispoli, 2010). Children who rely on these devices for communication will necessarily learn new communicative skills through their devices. Because of the increasing interest in and availability of these types of devices, it is growing increasingly important for speech-language pathologists to be aware of the possible uses of these devices to teach children with autism new communicative skills.

Objectives

The primary objective of this paper was to critically evaluate existing literature regarding the effectiveness of teaching new communicative skills to children with autism using a SGD. The secondary objective was to propose evidence-based practice recommendations for teaching new skills with a SGD to children with autism.

Methods

Search Strategy
The computerized databases CINAHL, Google Scholar, PubMed, PsycINFO, and SCOPUS were searched using the following terms: (autism spectrum disorder) OR (autism) OR (ASD) AND (speech-generating device) OR (voice output communication aid). In addition, relevant studies meeting the inclusion criteria referenced within acquired articles were included.

Selection Criteria
Studies selected for inclusion in this critical review paper were required to investigate the use of a SGD to teach children with autism a new communicative skill. Studies which instead focused on teaching the use of the SGD itself were excluded from this paper. No limits were placed on the intervention program, study design, or outcome measures. One study (Van Acker & Grant, 1995) was excluded as it investigated participants with Rett syndrome. While children with Rett syndrome

display similar characteristics to those with autism, it is a progressive neurological disorder which occurs in females (Trevathan & Naidu, 1988).

Data Collection
Results of the literature search yielded the following types of articles which met the above selection criteria: single subject ABAB, multiple baseline across participants (3), multiple baseline across settings, narrative review, and literature review.

Results

Results are organized chronologically into three primary categories. *Earlier SGDs* includes studies on devices that were used previously. Some of these devices are still used, but are not the most modern. *iPod-Based SGDs* comprises the studies on applications used on the iPod Touch. The *Reviews* section includes a narrative and literature review of available technology.

Earlier SGDs

Dyches (1998) used a single subject ABAB design across four students selected based on their limited communication. The students ranged in age from 10-12 years old; two had autism and two had a severe intellectual disability. The study taught the use of a switch ("Big Red" or Jellybean) with a pre-recorded message (e.g., "I want a drink"). A switch is a basic form of AAC in which the student presses a button to play a pre-recorded message.

The study aimed to address previously stated research needs involving AAC users. Four variables were measured: number of communicative interactions, number of spontaneous communicative interactions, percentage of independent communicative interactions, and number of verbalizations. Data on these were taken throughout the entire day the students were at school. Interrater reliability was found to be 95.2%.

Teaching took place in naturalistic settings throughout the day in a classroom environment. Soda pop was used as a reinforcer as it was highly motivating to the students and was not usually available. In addition, the switches were available throughout the day in order for students to have the opportunity to request pop at any time. A system of least prompts was used to teach the use of the switch.

The study concluded that all four students increased their number of communicative interactions and that both students with autism increased their spontaneous communicative interactions. These results are limited

because the paper presented only means and ranges rather than statistical calculations.

This study represents level 1 evidence. The fact that it used only one item for students to request limits its utility. In addition, the students already demonstrated the ability to request the pop, as shown in the baseline phase; for example, they could sign "drink," point to a picture of pop, or verbally indicate their desire for a drink. Therefore, the use of the switch for the purpose of obtaining a drink would not have been necessarily functional for the children in the study. In addition, the novelty of obtaining a drink may have declined throughout the study. Allowing the students to make additional requests may have been more effective in demonstrating whether children with autism can be taught new skills with this SGD, although this study does show the efficacy of the switch for increasing communicative intents.

Brady (2000) studied two 5-year-olds with severe cognitive disabilities (one with autism and one with a suspected traumatic brain injury). The two children were taught the use of a VOCA (a Jellybean switch on a SpeakEasy device) to request items of interest in their classroom setting. While the author described this study as a case study design, the baseline and subsequent measures taken represent a multiple baseline across settings design.

The in-depth VOCA instruction procedures used in the study are provided in the article. During a preferred activity, the author withheld an item required for completion of the task and asked the child "What do you need?" If the child did not respond, she was physically prompted to select the correct symbol.

Results demonstrated that the child with autism successfully met criterion (90% accuracy) for symbol selection and use of the VOCA; in addition, she demonstrated increased comprehension of speech production of the items. Statistical analyses were not conducted; rather the number of requests per session was measured. The author described the improved comprehension of speech as a potential "additional bonus" to VOCA use (p. 203), as the only time the children heard the labels for the items was when the VOCA spoke the labels (i.e., the author did not verbalize the object names). Inter-rater and procedural reliability measures were over 90%.

The study qualifies as level 1 evidence for the acquisition of requesting skills and comprehension of object labels following VOCA teaching. The study design was limited in terms of teaching requesting as the child was required to request a specific item. This

does not allow for true requesting in which the child requests something they want that is not immediately present. In addition, only six items were learned by the child during the study.

Choi, O'Reilly, Sigafoos, and Lancioni (2010) used a multiple baseline across participants design with four children, ranging in age from 6.5-9.5 years old. Three of the four children were diagnosed with autism and the other had severe developmental disabilities. Devices used included a Vantage, TechSpeak, Springboard, and picture exchange. The children had used these devices previously to request; this study taught the more advanced skills of rejecting and re-requesting, i.e., missing-item and wrong-item formats. A preference assessment was conducted in consultation with teachers prior to the start of the experiment to determine motivating activities.

The study consisted of three phases. First, pre-training taught the children to request missing items. Next, the experimental design taught rejecting and re-requesting responses. This phase consisted of baseline, training, intensive training for one of the four students, generalization, and follow-up. Interobserver agreement and procedural integrity were measured to be at least 95% for each of the four participants.

The study found that the children were successful in learning to request and reject items using their SGDs. In addition, the skills generalized and were maintained over four weeks following the study completion.

iPod-Based SGDs

Achmadi (2010) used a multiple baseline across participants design and taught two individuals with autism (13 and 17 years old) to make multiple step requests with Proloquo2Go. The students had previously been taught to make basic requests (see van der Meer, 2011 [described below]; Kagohara et al, 2010). Multiple step requests consisted of selections within a category chosen by the child. For example, if he selected "I want to eat," he would then see a screen with the choices for "I want a cookie," "I want a lolly," and "I want chips."

The study consisted of a baseline phase, intervention, and follow-up. During baseline, a fixed-time schedule of reinforcement was used to maintain the child's motivation to participate in the study, i.e., he still received reinforcement after 30 seconds even if he had not requested something. During intervention, the child was prompted verbally and then physically to correctly use the SGD.

The study also taught the children how to turn on and navigate the iPod Touch to get to the correct program and screen. This was taught through a backward chaining approach with similar prompting to that described above. Interrater agreement was found to be at least 92% for both children in each phase of the study, and treatment integrity was 87% for one child and 100% for the other.

An appropriate statistical analyses was conducted which consisted of visual analysis of the slopes of the multiple baseline graph, an independent t-test, and Cohen's d. The intervention strategies were found to be moderately effective in teaching multiple step requests.

One weakness of the methodology of the study is the level of prompting used. In baseline and follow-up phases, the students were still asked by the examiner "Can you turn on the iPod?" "Can you turn on the screen?" and "Let me know if you want something." The students' requests are therefore not spontaneous because they are consistently being guided through each step of the use of the device. Other studies have demonstrated successful teaching of spontaneous requesting to children with autism (e.g., PECS, Bondy & Frost, 1994), and it would have been beneficial to know whether these spontaneous requests could also be taught using this SGD.

This study's design represents level 1 evidence. However, since it is an unpublished master's thesis and therefore not peer reviewed, it may provide suggestive evidence that merits further research.

van der Meer et al. (2011) used a multiple baseline across participants design with three participants; one with autism (13 years old) and two with developmental disabilities (14 and 23 years old). The participants were selected based on related diagnoses, expressive language delays, and lack of prior exposure to SGDs.

A four-phase intervention sequence took place during the study consisting of baseline, acquisition training, post-training, and follow-up.

The screen on the iPod Touch showed three picture symbols: one to request a snack, toy, or social interaction. Students were told "Let me know if you want a snack/toy" and then reinforced on a 30 second fixed time schedule of reinforcement described in the Achmadi (2010) study above.

This study demonstrates that students with autism can effectively learn basic requesting with a SGD. Additionally, minimal teaching time was required, i.e., two to four 5 minute sessions conducted two days per

week, which is suggestive of rapid learning. This is clinically significant as many students with disabilities spend a large amount of time in intensive intervention programs.

Reviews

Mirenda (2003) wrote a narrative review of research and directions for future research on preferable AAC modality and what is known about VOCAs for people with autism. Nine studies were described in the section of this paper on VOCAs. The article provides an in-depth summary of the current research. Overall, it is reported that there is suggestive evidence that supports the use of VOCAs with children with autism in a school setting, but a great deal of future research is required. However, the author does not state the search parameters or selection criteria of studies included, nor does she compare the articles in any statistical manner. It is noted in the introduction that this type of paper provides "preliminary guidelines" for practicing speech-language pathologists rather than definitive answers on this area of research.

van der Meer and Rispoli (2010) conducted a systematic review of the literature on speech-generating devices for children with autism published between 1998 and 2009. Twenty-three studies were found which conducted intervention on a total of 51 children with autism. Eighty-six percent of these studies were found to report positive outcomes for the interventions.

This study used strict criteria for inclusion and did exclude 2 of the 25 studies yielded by the original search. For example, a formal autism diagnosis was required and case reports were not included. In addition, inter-rater agreement for inclusion in the study was required for each article.

Each study was coded for the number of participants, setting, mode of communication, the communication skill taught, intervention procedures, outcomes, follow-up and generalization, reliability and treatment integrity, and experimental design and certainty of evidence. Studies were designated as providing conclusive evidence if they used a systematic manipulation of the intervention, such as a multiple baseline or ABAB design. Conversely, studies were inconclusive if they used a treatment only, AB, or case study design. Five of the studies included in the review were found to provide inconclusive evidence.

Overall, the study reported that there have been no large-scale randomized control trials in this area. Instead, single-case designs are the primary study design for examining intervention effects of SGDs with

children with autism. There was a trend toward teaching requesting, likely because this is a basic skill that may not have developed appropriately in children with autism. In addition, most studies adapted the intervention procedures to the communicative skill being taught; more specifically, requesting was generally taught through operant/behavioural techniques whereas more social and conversational skills seemed better suited to more naturalistic methods.

Interestingly, because this study was published in 2010, no studies examining iPod-based devices were included as no such studies had yet been published.

Discussion

The literature to date suggests that SGDs can be used to teach children with autism new communicative skills. The studies reviewed here demonstrate the effective use of SGDs to teach children with autism basic requesting skills, and qualify as level 1 research evidence. While no randomized control trials have been conducted, these smaller scale n-of-1 studies represent strong evidence, especially with a large number of studies. However, the research is scarce regarding SGDs in autism, especially when considering the increasing rate of autism diagnosis (Boyle et al., 2011).

Literature on the iPod Touch represents a growing body of evidence of its efficacy as an AAC device. It should be noted that there are several AAC programs available on the iPod Touch, but the only program with any empirical research evidence is Proloquo2Go.

A major limitation of the literature on SGDs is that the majority of studies taught only basic forms of communication (i.e., requesting). This limits the functionality of the devices for the children because they cannot use their device to communicate for social or more advanced communicative purposes. Dyches (1998) and Brady (2000) used basic switches and children were taught a limited number of messages. Choi et al. (2010) taught a more advanced sequence on the SGD, but this was still limited to requesting. Similarly, the studies on the iPod Touch also focused on teaching requesting. It is not clear whether more advanced skills have not been taught because children with autism have more difficulty learning these skills or simply because it is difficult to design a study to examine teaching more advanced communicative skills on a SGD.

The following recommendations for future research may lead to advancements in the clinical knowledge base in the area of SGDs with children with autism:

- teaching more advanced communication, such as longer utterances and a greater number of functions, such as commenting
- determining how to choose the most appropriate device for a child
- comparing iPod devices to other SGDs
- teaching use of SGDs in more natural environments rather than just a school setting
- comparing intervention methodologies to determine the most effective teaching style for children with autism

Conclusion and Clinical Implications

The use of SGDs may be an appropriate way to teach children with autism new communicative skills. In particular, recent studies have demonstrated efficacy in teaching requesting through iPods, which may be less expensive, more portable, and more socially accepted than other devices (van der Meer et al., 2011). Future clinical research should focus on the above recommendations.

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