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Speech Generating Devices for Children: A Guide for Parents and Caregivers

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Speech Generating Devices for Children: A Guide for Parents and Caregivers

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Report

Presented to the Faculty of the Graduate School of

The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

Master of Arts

The University of Texas at Austin

May 2016

Acknowledgements

I would like to express my gratitude to Dr. Jessica H. Franco for her encouragement and guidance throughout the process of this master's report and throughout my graduate program. Furthermore, I would like to thank Dr. Li Sheng for her valuable editorial assistance. Lastly, I am forever grateful to my family and friends for their love and support throughout this entire process.

Abstract

Speech Generating Devices for Children: A Guide for Parents and Caregivers

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The University of Texas at Austin, 2016

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Children with severe communication deficits often need alternative methods to supplement existing speech or replace speech that is not functional. Research indicates that augmentative and alternative communication (AAC) methods can improve communicative function in low or nonverbal children. A prevalent form of AAC is the Speech-Generating Device (SGD), which produces synthesized or recorded speech. Numerous SGDs, downloadable applications, and accessories are on the market alongside a vast array of published literature. As a result, it is difficult for parents to educate themselves when considering an SGD for their child. This paper will serve as a guide to help parents understand SGDs and the ways in which they may benefit their child.

Table of Contents

List of Tables

Chapter One: Introduction

Children with severe communication deficits often find themselves isolated from others and unable to express their thoughts, desires, or even basic needs. However, research suggests that some individuals may benefit from using methods of augmentative and alternative communication (AAC). AAC is a set of procedures or technology that replaces natural speech to maximize functional communication (Myrden, Schudlo, Weyand, Zeyl, and Chau, 2014). These alternative methods are used to help individuals express themselves to others. People with severe speech or language problems rely on AAC to supplement existing speech or replace speech that is not functional. Children who use AAC have a variety of different communication needs and vary in their expressive and receptive language abilities. Children may use AAC temporarily or may use it as permanent means of receptive and expressive communication (Von Tetzchner & Martinsen, 1992). Modalities of AAC include nonverbal communication means such as manual signs, pictures, or electronic devices that produce synthesized speech.

One type of AAC device is the Speech-Generating Device (SGD) also known as a Voice Output Communication Aid (VOCA). These devices produce either synthesized or recorded speech output (Waddington, Sigafoos, Lancioni, O'Reilly, Van der Meer, Carnett, & Marschik, 2014) enabling children to 'speak' in ways that they cannot independently. There are a large number of SGDs on the market today, and use of these devices has become widespread for children who struggle with verbal communication.

Given the popularity and variety of SGDs available today, parents and other members of the child's team need to be knowledgeable when selecting a device for a child. There is a great deal of research available on SGD use for children in today's literature. Independently, each study offers information about the capabilities of these devices and how they may improve communication for children with various disabilities and impairments. However, the research is vast and largely inaccessible to parents of these children. Parents may be unfamiliar with AAC in general, might not understand how it could specifically help their child, and likely will not understand the terminology that is used in this area of technology. Whether exploring SGD use with their child for the first time, or wanting to switch to a new device, parents need a resource that can explain the options.

This paper will operate as a parent's guide for choosing and customizing an SGD device for their child. The paper will review the current literature on SGDs for children, discuss populations of children that may benefit from SGDs, and evaluate communicative functions that SGDs can target. Furthermore, it will define technical terminology for parents, describe multiple devices in detail, and discuss currently available SG applications for tablets. Additionally, the paper will educate parents on how to best select and customize a device for their child. Finally, this document will summarize the information, offer a way for parents to have constructive conversations with their child's speech-language pathologist (SLP), and improve the quality of life for their child.

WHAT IS AAC?

There are two major types of AAC methods: aided and unaided. Unaided techniques require only the body to communication and can include gestures, sign language, and facial expressions. Aided systems require the use of external equipment to enable the individual to communicate (Lorah, Tincani, Dodge, Gilroy, Hickey, & Hantula, 2013; Van der Meer & Rispoli, 2010). These aided AAC devices can be grouped into low, mid, or high-tech. Low-tech augmentative and alternative communication systems include non- electronic devices such as printed communication boards or a picture exchange (PE) system (Lorah et al., 2013; Van der Meer & Rispoli, 2010). A communication board contains an array of pictures and symbols that correspond to an item or activity. The child is taught to point to the picture of the desired item to functionally communicate. A PE system such as the Picture Exchange Communication System (PECS) created by Bondy and Frost, requires the child to hand the picture of the desired item to a communication partner. In this way, the child communicates their wants and needs (Bondy & Frost, 2001). Mid- tech communication systems include electronic devices with a single static display and/or a scanning system with one level of choice. Finally, high-tech augmentative and alternative communication systems have dynamic displays and/or several layers of choices (Myrden et al., 2014).

High-tech AAC options have become prevalent over the past 20 years. Technological advances have allowed the design of AAC devices to become both complex and easy to use. Rather than producing a single output for each input, these devices are coded, permitting multiple possible outputs for a limited number of inputs. In comparison to static boards, dynamic screen communication devices provide a larger vocabulary to the user at one time, enabling more natural and responsive communication (Myrden et al., 2014).

The SGD is a mid- and high-tech device that has become prevalent in current research and intervention. This devices display an array of pictures and graphic symbols that represent a spoken word or message. The operator uses a finger, hand, or another device to select the symbol, which then produces the spoken message. These devices are often small and easily portable (Waddington, Sigafoos, Lancioni, O'Reilly, Van der Meer, Carnett, & Marschik, 2014, Van der Meer & Rispoli, 2010). An SGD may be a machine that functions only as a communication device, but more often the AAC option is an application within form of an iPad or other tablet computer that has been loaded with speech-generating software. SGDs are commonly examined in current research and are often determined to be a useful tool to improve communication skills in children with low verbal output.

Chapter Two: Literature Review

There is a large quantity of published research available on SGD use for children. It is paramount that parents and therapists familiarize themselves with current literature in order to understand the types of devices available and choose the one that will optimally fit the child and meet their communications needs. This section of the paper will review current studies in which children were taught to use a SGD. The research is summarized and limitations are discussed. This review aims to educate and assist parents in their efforts to provide alternative communication methods to their children.

METHODS

The following review of current AAC literature included a search of the databases Medline, Ebsco Host, PubMed using a combination of the following free-text terms with truncation and Boolean operators: augmentative and alternative communication (AAC), children, iPad, voice output communication aid, speech generating device, language, and intervention. The search was limited to English-language, peer-reviewed journals, and articles published after 1999.

To be included in this review, the article was required to evaluate low or nonverbal children, 12 years or younger when using an SGD device. The study had to be specifically used for the purpose of increasing or improving expressive or receptive communication skills. Included studies also had to provide empirical data on the effects of the AAC-based intervention. Ten studies met the criteria and are summarized in terms of (a) population, (b) specific SGD devices, and (c) SGD communicative function.

Results

Table I summarizes the participant characteristics, targeted communication skills, SGD characteristics, intervention procedures, and results of these 10 studies.

Table 1. SGD communication interventions.

Citation	Participant characteristics	SGD function and description of SGD	Intervention Procedure	Results
Brady, 2000	1 male, 1 female, M= 5yrs, ASD, TBI	*Function:* Requesting objects *SGD:* SpeakEasy with switch	Graphic symbols were placed on rough 2-inch diameter Jellybean switches and connected to the SpeakEasy, which would voice the name of the referent. The experimenter began each session routine by announcing it by name (e.g., "It's time to listen to music" (tape routine),"Let's make a picture" (pic- ture/glitter routine), or "Let's make a snack" (snack routine). The appropriate materials were then placed on a table, including the 3 objects represented on the VOCA. The experimenter then asked "What do we need first?" while holding up the first object needed in the routine. If the participant selected the appropriate symbol, the experimenter gave him or her the object and continued the routine	Both participants increased requesting for objects and showed increased comprehension skills for the names of six objects using VOCAs.
Choi et al., 2010	4 males, M= 8 yrs, developmental disabilities, ASD, severe communication impairment	*Function:* Request missing items and reject wrong items *SGD:* Tech Speak, Vantage, Springboard	During the training sessions, requesting was defined as pressing the correct icon for the missing-item on their SGD. In the training phase, rejecting was defined as pressing the ''no'' icon button when the presented item did not correspond to the requested item within 10 s.	All participants acquired the targeted requesting and rejecting responses. The rejecting responses generalized across two untrained activities and were maintained for up to 4 weeks following intervention for 3 of the 4 participants.
Dicarlo & Banajee, 2000	2 males, M = 26 months, nonverbal, developmental delay and Angelman Syndrome	*Functio*n: Initiated social interaction; Decrease in unclear communication behaviors *SGD*: Alpha Talker (8 pictures, moved to 16 then 20 pics during	Snack related items were placed on table. If no response was made to request these items, adult verbally prompted participant indirectly by saying "Look, I have. . ." or "who wants ... . ?" If no response followed these verbal prompts, the participant was provided with a choice of two preferred items.	One participant increased the percentage of intervals in which he made specific initiations by 41%. Unclear initiative behavior decreased by

Table 1. (continued)

		intervention)		20% and prompted behaviors remained similar to baseline at levels of 22%. The other participant's specific initiations remained at an increased level relative to baseline. Unclear initiative behavior decreased by 5% and prompted behaviors decreased 18%.
Flores et al., 2012	5 males, M= 9 yrs, ASD, intellectual disability, multiple disabilities	*Function:* Requesting snack items *SGD:* iPad with "Pick a Word"	Students were trained and assessed in both a picture exchange condition and an iPad condition. At snack time, the teacher told the students that they would take turns asking which snack they wanted and if they wanted a drink. She asked the first student want he wanted. If the student responded using pictures or the iPad (depending on the condition) within 5 s she gave a small amount of food and/or drink. If the student did not respond within 5 s the teacher told him that it was the next student's turn and then asked the next student what he wanted. After the initial round of teacher-initiated opportunities for each individual student, the students, as a group, were offered more. The whole activity lasted for 15 min; for the last 10 min of the activity, all students had unlimited opportunities to request snacks.	Results showed higher levels of requesting in the iPad condition for 3 participants and equal levels of requesting for iPad and PE for the other 2 participants. However, the iPad was new at the time (had not been released to the public) and the participants had previous training on a PE system.
Lee at al., 2013	Experimental group: 4 males, 1 female, M= 9 yrs, nonverbal with sign, gestures, vocalizations, or unintelligible words, intellectual disability and/or cerebral palsy, cochlear implants for over 2	*Function:* Requesting objects, Communication behaviors (spontaneous vocalizations, spontaneous gestures, spontaneous words, and imitative words) speech perception, speech production, and receptive	Children learned symbols by requesting a preferred object by pointing to pictures and photos which on the VOCA. Researchers used routinized events (e.g., snack time, and simple board games, etc.) to teach children linguistic and nonlinguistic patterns that accompany routines.	All 4 participants increased frequency of spontaneous communicative behaviors and imitative words to a significant degree fter AAC intervention ($p < .05$). All children

Table 1. (continued)

	years Control group: 5 males, M=9 years, nonverbal with sign, gestures, vocalizations, or unintelligible words, intellectual disability and/or cerebral palsy, cochlear implants for over 2 years	vocabulary skills. *SGD:* KidsVoice		exhibited significant improvement in speech perception (26% to 48%), speech production (17% to 35%), and receptive vocabulary skills (11% to 18.4%) after AAC intervention. Some children in the control group showed improvement in the speech perception, speech production, and receptive vocabulary tests for 6 months, but the differences did not achieve statistical significance (all $p > .05$).
Lorah et al., 2013	5 males, M= 4.5 yrs, ASD	*Function*: Requesting preferred items *SGD*: iPad 2, Proloquo2go	The researcher presented each participant with 3 preferred items and instructed him to "pick one." Immediately after the reaching response, either the PE device or the iPad was placed in front of the participant, with the picture depicting the item on the PE book or iPad screen, in a field of one picture. The item remained in view of the participant but beyond his reach. Following prompted or independent responding, the participant was granted access to the item for 30 s after which the item was removed and the next trial began.	4 out of 5 participants were more successful making requests with an iPad than a picture exchange system and 4 out of 5 participants demonstrated preference for the iPad over the PE system.

Table 1. (continued)

Romski et al., 2010	43 males, 19 females, M= 2.5 yrs, limited verbal (< 10 words), genetic syndromes, seizure disorders, cerebral palsy, unknown conditions	*Function*: Vocabulary using SGD output, vocabulary using verbal output *SGDs*: CheapTalk, Communication Builder, GoTalk, TechSpeak, TechTalk.	Each child and one parent were assigned to one of three different intervention groups: augmented communication input, augmented communication output, and spoken communication. Parents were trained on their specific intervention protocol through a manual, observations of the project's SLP, co-teaching with the SLP, and finally performing communication intervention on their own with the child at home. All 3 intervention methods used age-appropriate naturalistic routines, provision of choices, environmental arrangement, and pausing to encourage communication from the child.	Vocabulary size was larger in all 3 groups at the completion of intervention, but spoken vocabulary was larger in the 2 augmented communication groups than in the spoken communication intervention group.
Sigafoos et al., 2003	3 males, M= 7 yrs, Leber's Congenital Amaurosis, severe ID, severe ASD	*Function:* Requesting preferred food or toys; Vocalizations *SGD*: BIGmack switch	During intervention sessions, a trainer and child sat at a table. A tray with preferred foods, drinks, and toys was placed on the table in view of the child, but out of the child's reach. A BIGmack switch was placed on the table within the child's reach. Touching the BIGmack switch resulted in the message ''I want more.'' Sessions began by giving the child a small sample of each available item. Next, the trainer moved the tray of objects out of reach and said, "Let me know if you want more." SGD requesting was recorded when a child pressed the BIGmack switch with sufficient force to activate the message. Vocalization was recorded when a child produced a clearly audible vocalization that included a speech-like sound.	All 3 participants increased their number of requests using the SGD. SGD use did not reduce vocalizations and 1 participant began saying single words toward the end of intervention.
Van der Meer et al., 2012	2 males, 2 females, M= 10 yrs, developmental disabilities, Angelman Syndrome, PDD-NOS, and ASD	*Function:* Requesting snacks or play *SGD*: iPad and iPod touch	Children were taught to make general requests for preferred items (snacks or play) using a speech- generating device (SGD), picture-exchange (PE), and manual signs (MS).	All participants were able to improve requests with an SGD or PE, but only 2 children reached criteria level with manual sign. For the AAC preference assessments, three participants chose the SGD most frequently,

Table 1. (continued)

				while the other participant chose PE most frequently.
Van der Meer, Kagohara				
Waddington et al., 2014	3 males, M= 8 yrs, ASD	*Function*: Multi-step communication sequence; requesting general preferred item (toys or drawing materials), requesting specific item (e.g. ball or crayon), and a "thank you" response. *SGD*: iPad 2, Proloquo2go	The child was seated at a table and the iPad was placed within the child's reach.. A tray with the 2 preferred items was on a chair beside the clinician, but out of the child's view. The clinician would show the child the tray and ask "Would you like anything?" During the first step of the sequence the child had to make a general request by tapping the general to) or drawing icon (dependent on the child). If the child did not respond, the clinician would prompt the child with first a gesture and verbal prompt. If the child still did not respond, the clinician moved the child's hand onto the icon on the iPad. Second, the child had to make a specific request for 1 of his 2 preferred toys by pressing the photo of one of two available icons. This second step in the sequence had to occur within 10 s of being asked, "Which toy would you like?" or "Which would you like to use?." The final step in the sequence was to activate the icon for making a "thank you" response upon receiving the requested item.	All participants showed improvement in performing the communication sequence. This improvement was maintained with an unfamiliar communication partner and during the follow-up sessions.

Populations

Populations of children that may benefit from SGDs include those with Down syndrome, Cerebral Palsy (CP), Pervasive Developmental Disorder Not Otherwise Specified (PPD-NOS), Apraxia, Autism Spectrum Disorders (ASD), traumatic brain injury (TBI), intellectual disabilities, and other conditions that cause impairments in communication.

Ten of the studies included children with ASD. ASD is a form of developmental disability that often presents with deficits in communication, social skills, relating to others, understanding language, and participating in appropriate play (Flores, Musgrove, Renner, Hinton, Strozier, Franklin, & Hil, 2012). Communication deficits are often severe, and some individuals with ASD may not develop sufficient speech to meet everyday communication needs (Waddington, Sigafoos, Lancioni, O'Reilly, Van der Meer, Carnett, & Marschik, 2014). However, multiple research studies (Van der Meer, Sutherland, O'Reilly, Lancioni, & Sigafoos, 2012; Lorah, Tincani, Dodge, Gilroy, Hickey, & Hantula, 2013; Waddington et al., 2014; Son, Sigafoos, O'Reilly, & Lancioni, 2006; Brady, 2000; Flores et al., 2012) suggest that AAC devices may be effective in improving communication skills in children with ASD. A study by Nancy Brady (2000) studied one child with ASD and one child with delays in language and cognition due to TBI. Another study by Lorah et al. (2013) sought to teach specific requests to 5 children with ASD using an iPad. A study by Waddington et al. (2014) evaluated three children with ASD. Results of these studies showed an increase in communicative attempts in

90% of participants. This data suggests that using SGDs may increase communication in children with ASD.

Two of the studies included children with CP. CP is a movement disorder caused by damage to the brain before, during, or soon after birth. Communication difficulties can occur with any of the various types of CP and may result in limitations in the production of movements for speech, gesture, facial expression, receptive or expressive language, hearing, vision, or a combination of limitations. Prevalence of speech, language and communication impairment increases with severity of motor and intellectual impairment (Pennington, Goldbart, & Marshall, 2011). Depending on the type and severity of CP, children often need to use eye gaze, eye scanning, or a large switch/button pressed by the hand, head, or foot to choose the desired message. A study by Pinto & Gardner (2014) used an iPad and eye gaze with an 8-year-old girl diagnosed with quadriplegic athetoid cerebral palsy and seizure disorder. A study by Clarke and Wilkinson (2007) examined two children with CP and evaluated AAC use to improve peer interactions in one child and improve grammar in the other. Both children used a switch device, one operated by the head and the other by the hand. The authors of these studies report improved communication in all participants, indicating that children with CP may benefit from using SGDs.

The reviewed studies also examined children with other disorders that cause impairments in communication. A study by Dicarlo and Banajee (2000) evaluated two young boys ages 24 and 28 months identified with special needs. One child was diagnosed with a chromosome abnormality and the other had been diagnosed with Angelman Syndrome. Lee at al. (2005) examined 5 children with multiple disabilities who received cochlear impacts (CIs). Sigafoos, Didden, & O'Reilly (2003) evaluated three children with developmental disabilities. One child was diagnosed with Leber's

Congenital Amaurosis (ACL), another had severe intellectual disability, and the third had severe ASD. Romski, Sevcik, Adamson, Cheslock, Smith, Barker, & Bakeman (2010) examined subjects with Down syndrome or other genetic disorders, Cerebral Palsy, seizure disorders, and unknown conditions. Collectively, these studies report that 99% of participants showed an increase in communicative attempts. These results suggest that communication intervention using SGDs may be beneficial for children across a variety of diagnoses.

Types of SGDs

Four studies examined communication in children using iPads with Proloquo2go as the SG application. A study by Waddington et al., 2014 taught children to complete multi-step communication sequences using an iPad with Proloquo2go. A study by Van der Meer et al. (2012) compared acquisition of requesting and preference between an iPad with Proloquo2go, manual sign (MS), and a PE board among four children. A study by Lorah et al., 2013 sought to teach specific requests to 5 children with ASD using an iPad. Four out of five children were more successful producing requests with an iPad over PE. Flores et al. (2012) compared requesting with an iPad versus a PE system and deduced that three of the five children showed higher levels of requesting in the iPad condition. The researchers note that all children had previous experience with a PE system and that participants and parents were unfamiliar with iPads as they had not been released to the general public at the time of the study.

Six studies evaluated traditional SG devices. Son et al. used the Tech/Talk for a study in 2006. The Tech/Talk is a 6x8 device (manufactured by Advanced Multimedia Services) that consists of eight panels. Each panel can accommodate a 5x5 cm graphic symbol and hold a digitized recorded message. Choi et al. (2010) placed one subject on a

TechSpeak device (Advanced Multimedia Devices, Inc.) that had 32 square pictures to choose from to target requesting and rejecting responses. Another participant was given a Springboard SGD (Prentke Romich Company), which had about 30 icons. A third participant was trained on a Vantage (Prentke Romich Company), which showed 45 icons on the first screen and required the child to also press a button on the second screen for a specific request.

Four studies examined SGDs that utilize switches that only produce a single or a few responses. These are used for students who do not have the physical or cognitive abilities to choose from an array of items and press the appropriate symbol. A study by Sigafoos et al. (2003) used the BIGmack (AbleNet, Inc.), a 12.7 cm in diameter button that is easy to operate. When the switch is pressed, a voice speaks the pre-recorded massage. The study used the BigMack to teach three children to make requests. Nancy Brady (2000) used the SpeakEasy attached to 2-inch diameter Jellybean. Graphic symbols were placed on the switches and connected to the SpeakEasy, which would voice the name of the referent. Dicarlo et al., (2000) placed one participant on the Alpha Talker (available from Pretnke-Romich) a device with one small switch, and placed the other subject on a Dual Rocking Lever Switch (from Enabling Devices) which hard a large surface separating only two items on the screen at a time. A study by Clarke and Wilkinson (2007) examined two children with CP in which, both children used a switch device. One child used the Delta Talker, with a switch operated by the head and one, the Liberator, operated by the hand.

SGD Communicative Function

Eight articles examined requesting objects or food. Lorah et al., 2013 sought to teach specific requests to 5 children with ASD, and were more successful using an iPad over a picture exchange (PE) system with four out of five children. A study by Van der Meer et al. (2012) taught four children to make requests using manual sign (MS), a PE board, or an SGD (either an iPod tough or iPad with Prologuo2Go). There are also studies that evaluate initiating communication through SGDs. In Dicarlo and Banajee (2000), two nonverbal boys with developmental delay increased their specific initiations and decreased their previously used unclear attempts at communication (e.g. grunting, waving arms).

One study by Waddington et al., 2014 taught children to complete multi-step communication sequences. The children were taught to first make a general request for access to toys or drawing materials, then request a specific item, and finally say thank you after receiving the requested item. All three of the children in the study improved in performing the sequence and maintained that improvement during follow-up session with an unfamiliar communication partner.

There were also two studies that suggest using AAC can actually increase spoken output. Sigafoos et al. (2003) not only found that the SGDs improved the number of requests in its subjects, but one child began saying single words toward the end of intervention. Similarly, Romski et al. (2010) measured spoken vocabulary size in three different intervention groups: augmented communication input, augmented communication output, and spoken communication. Vocabulary size was larger in all three groups at the completion of intervention, but spoken vocabulary was larger in the two augmented communication groups than in the spoken communication intervention group.

Summary

Several limitations are present in the current research of SGDs for children. Most published studies on AAC compare a high-tech method to a low-tech method such as a PE system or manual signing system (Lorah et al., 2013; Flores et al. 2012; Van der Meer et al., 2012). The literature is lacking in research that compares different types of high-tech methods to one another to determine the best device for a certain type of client or population.

The sample sizes for the studies mentioned in this review were all small (range of 1-6) except for the Romski study that had 62 participants. Only one study in this literature review addresses maintenance of communication skills (Waddington at al., 2014). The other studies do not address maintenance or generalization, but acknowledge this as a limitation and a direction for future research.

Although the current research covers quite a few types of SGD devices, there are still many more that have not been thoroughly studied. This researcher could not locate any studies conducted using a Dynavox device, even though the company is a large producer of SGDs. More studies must be conducted on the various types of available SGDs. Similarly, there are many available SGD applications for iPad (Speak4Yourself, Touch Chat, and LAMP Words for Life) but this researcher only found studies utilizing Proloquo2go.

Chapter Three: Parent Guide

In order to choose the best SGD option for their child and communicate with a child's SLP, a parent must familiarize themselves with the technology and options available. This section of the paper will define SGD terminology for parents, describe multiple SGDs available on the market, explain SGD applications that can be uploaded on to tablets, and guide parents on how to best choose and customize a device for their child.

SGD Terminology

In order to understand SGD technology and how to use it, a person must be familiar with the terminology used in the field. This section will cover the following terminology: Access, scanning, page sets, keyguards,

Access

Access refers to the way a user makes selections on an SGD (Fager, Bardach, Russell, & Higginbotham, 2012). The two primary access methods are direct selection and scanning. Direct selection requires the user to touch the desired button (symbol/word/letter/phrase) with a body part such as a finger, hand, or toe, or using a pointing device such headstick, mouthstick, or beam of light. Those with severe physical impairments may need to access systems by using a switch. The switches can be turned on with a body part, puff of air, or with eye movement (Fager et al., 2012; Myrden et al., 2014). Indirect access involves a process called scanning.

Scanning

Scanning requires the user to wait while the device moves through choices that are displayed in sections. The user then activates a switch to indicate a choice the desired choice (Fager et al., 2012; Myrden et al., 2014). There are two primary modes of scanning. Visual scanning requires the operator to follow visual cues such as lights or highlights, which can occur in a variety of patterns. Auditory scanning requires the user to listen to auditory cues in order to follow the scanning pattern (Fager et al., 2012; Myrden et al., 2014). There are also several types of scanning patterns used in AAC devices. Step Scanning requires the user to activate a switch each time he or she wants the system to move to the next selection. Linear scanning is a process in which a cursor moves from one item to the next through the entire set in a linear fashion (Fager et al., 2012; Myrden et al., 2014). Row/Column scanning highlights one entire row at a time until a switch is activated to make it stop, then each column is highlighted, until a switch is triggered a second time, this time selecting the desired symbol. Group-Row-Item scanning highlights the top and bottom halves of the selection set, until the user activates a switch, then the system highlights each row in that half of the display until the switch is triggered a second time. Finally, the cursor highlights each individual item until selection (Fager et al., 2012; Myrden et al., 2014). Circular scanning is scanning on a circular display, where the cursor sweeps around the display much like the "second hand" of a clock. Inverse scanning is another method that could be beneficial to certain users. In inverse scanning the user must activate a switch to maintain movement of the scanner rather than the scanner moving automatically through the choices. This method reduces the timing requirement, is used when the release of a switch is the more coordinated action, or when maintaining a position is easier than repeating it. Scanning requires less motor control but possibly more cognitive skill than direct selection access (Fager et al., 2012; Myrden et al., 2014).

Keyguards

A keyguard is a plate which sits over a keyboard or touch screen, with spaces that a user can put their fingers or a pointer through to hit the keys. Users who have trouble with fine motor control often find that keyguards help them to hit the key they're aiming for, and users who have weakness or fatigue that makes it difficult to hold up their arm can rest their hand on the keyguard while pressing keys (Fager et al., 2012; Myrden et al., 2014).

Word Completion

Word completion systems work when using text-to-speech. They use predictive language models to identify likely words that begin with already entered letters so that they can be presented to the user and selected with a single key- stroke, instead of requiring each remaining letter in the word to be individually typed. Individuals using a single switch for keyboard emulation (e.g., through eye blink or other switches when direct selection is difficult or impossible) can benefit from predictions regarding which stimuli to present or highlight for selection. (Roark, Fried-Oken, & Gibbons, 2015, Fager et al., 2012).

DESCRIPTION OF DEVICES

In the current market, SGDs come in the form of tablets that utilize specialized speech output software (iPad or Android tablets) and traditional devices. Tablets like the iPad are portable devices that are generally used to check email, browse the internet, and function as a small computer. However, technology has brought about software that turn the tablet into a SGD. These applications can be purchased through online stores (e.g Apple App Store) and allow for a variety of communication uses. A traditional device, is a mechanism explicitly created to function as a communication device. These devices come with SG software preloaded and often do not support internet or other personal uses (e.g. games, camera). However, in an attempt to keep up with tablets such as the iPad, traditional devices are adding internet capability and other amenities. In many cases, traditional devices are covered by Medicare, Medicaid, and third-party insurers while iPads are not.

iPads

The mobile technology revolution has allowed the utilization of smart phones and tablets for AAC. These mainstream communication tools offer several advantages over traditional systems. Using an iPad often makes for a convenient and easy transition as most adults and many children are accustomed to seeing and/or handling iPads. Likewise, iPad are socially acceptable devices that can lessen the stigma of using an AAC device. In addition, other children may be more apt to engage the child with an iPad SGD because they are acquainted and motivated by them. These multifunctional devices also provide access to mainstream phone applications, such as text messaging, e-mail, and internet browsing, which have become essential aspects of communication. They also allow the integration of personal photos, audio, and video. Using an iPad also allow a person to have their choice from a variety of AAC applications such as Proloquo2Go (AssistiveWare), LAMP Words for Life (Prentke Romich Company), TouchChat HD (TouchChat Inc.), GoTalk NOW (Attainment Company), and TalkingTILES (Mozzaz Corporation).

Traditional SGDs

One company that manufactures traditional SGDs is Tobii Dynavox. Tobii Dynavox offers a variety of devices, sizes, and customizable features. The T-Series consists of tablet-style devices in three different sizes: the T-7 (7” screen), T-10, (10” screen), and T-15 (15” screen). Each device includes both symbol-grid and text-to-speech systems. Access methods include touchscreen, keyboard, mouse/trackball, switch scanning with audio feedback, head tracking, or keyguards to support direct access. The T-Series includes voice output options in English (US, UK, AUS), German, French (CAN, FR), Spanish (US, ES), Portuguese (BR), Swedish, Norwegian, Danish, and Dutch (NL, BE), and includes new boy and girl voices in American English (US, UK, AUS), Spanish (US), and German. The symbols are currently available for English, German, Spanish, Swedish, Norwegian, Dutch, and Danish (Tobii Dynavox, 2016).

The I-Series+ consists of the Tobii Dynavox I-12+ and I-15+, two speech generating devices that can be controlled through gaze interaction via an optional built-in eye tracker. The I-Series+ is suited for individuals with motor impairments (e.g Cerebral Palsy). The software on the I-Series+ devices allows the user to communicate through speech, e-mail, text messaging, chat, Skype, or through phone calls using Bluetooth technology. I-Series+ devices also allow users to share photos, search the Internet, play games, and access regular computer applications (Tobii Dynavox, 2016)

Every Tobii SGD runs on Compass software, which contains pre-stored communication symbols, pictures, words, and phrases. It also includes additional built-in supports such as Behavior Supports and Scripts to help the user navigate through daily activities and conversations. Compass includes Pagesets, communication topics, and pre-stored messages for games, shops, restaurants, school, and favorite activities. The QuickFires and QuickPhrases pages allow the user to quickly choose from common words and phrases. Over 1400 high-contrast symbols have been added to Compass to assist individuals with low vision or visual impairments. Pagesets and symbols can be configured and customized to the user (Tobii Dynavox, 2016).

There are a several other SGDs being used in both research and intervention. The Prentke Romich Company manufactures the Accent series of SGDs. These devices come in a range of sizes and offer access via touch, eye gaze, single/dual switch scanning, eye tracking, and head tracking. The Accent includes a choice of vocabulary options featuring Unity® with LAMP/Words for Life™, CoreScanner™, and WordCore. Other available vocabulary options include Essence™ for literate adults and WordPower™. The Accent devices are powered by PRC's NuVoice™ software and offers built-in support resources for clinicians and clients (Prentke Romich Company, 2016).

The Attainment Company manufactures a variety of GoTalk devices. These devices range from a small four-picture display, up to a 32-picture display. The GoTalk requires a person (e.g caregiver) to create overlays that contain the desired pictures or symbols. The company offers software to help produce overlays. To use the GoTalk a caregiver, therapist, or child with verbal output must record messages for each corresponding picture (Attainment Company, 2016).

Advanced Multimedia Devices, Inc. offers multiple devices including the Tech/Talk, Tech/Speak, Tech/Chat, Tech/Scan, and Partner/Plus. These devices range from a single message system, to four, eight, 16, 32, and 128 message systems. To use these devices, a caregiver, therapist, or child with verbal output must record messages for each corresponding picture. The devices do not come preloaded with digital speech. The Tech/Talk is a 6x8 device that consists of eight panels. Each panel can accommodate a 5x5 cm graphic symbol and hold a digitized recorded message. The Tech/Talk with 8 levels allows a person to record 68 messages, eight messages behind each panel and button. The Tech/Speak, has 32 panels and allows for 12 levels of recorded messages. The devices use Real-Voice technology, providing speech playback at a high audio quality. They are made with a shatterproof high impact ABS injection molded case and are designed to be accidental drop resistant and water resistant. The devices are lightweight, portable and all units can be easily wheelchair or table mounted. The Tech/Talk with environmental control units (ECUs) allow the user to control electrical or infrared devices using the machine. The Tech/Scan and Smart/Scan can be used as a single or double switch scanner or as a direct select device. Both devices offer multiple scanning options, scanning speeds, and auditory prompts. The Smart/Scan also contains an option for customized scanning patterns and the amount of cells to be scanned can be programmed to allow the device to grow with the user's abilities (Advanced Multimedia Services, 2016).

Table 2. SGDs currently on the market

Device	Description	Manufacturer	Cost
Dynavox Tobii T-Series	Symbol-grid system and text-to-speech	Tobii Dynavox	Information Not Available
Dynavox Tobii I-Series+	Symbol-grid system and text-to-speech	Tobii Dynavox	Information Not Available
Tech/Talk	Symbol-grid system	Advanced Multimedia Devices Inc.	$395
Tech/Speak	Symbol-grid system	Advanced Multimedia Devices Inc.	$624
Access	Symbol-grid system and text-to-speech	Prentke Romich Company	Information Not Available
GoTalk	Symbol-grid system	Attainment Company	$159-$599
BIGmack	Single message	AbleNet	$129.99

Switch Devices

Many children who would benefit from AAC may not have the physical or cognitive capacity to use a complex system with multiple arrays like a tablet. These children can use single switch devices. These switches are easy to operate, only produce one or two speech-generated messages, or can be connected to another SGD device. One popular single switch is the BigMack switch (AbleNet, 2016) which is a circular button, 12.7 cm in diameter, which requires little force or accuracy to operate, and produces only one speech-generated message. Another option is a dual switch, which gives two choices. This switch is operated by pressing on either end of a plate located on top of the unit, with medium force. One end of the plate activates one switch and the opposite end activates another. There are also head and foot switches available for children who have the most control in those muscles (AbleNet, 2016).

APPLICATIONS FOR TABLETS

SGD applications allow a tablet to function as a communication device and are currently available for several platforms. These include Android, Windows, and iOS, which is Apple Inc.'s mobile operating system for iPads, iPhones, and iPods. This section of the paper will review the applications Proloquo2Go (AssistiveWare, 2016), LAMP Words for Life (AACApps, 2016), TouchChat HD (TouchChat, 2016), GoTalk NOW (Attainment Company, 2016), and TalkingTILES (Mozzaz Corporation, 2016).

One of the most widely used applications is Proloquo2go, a symbol-supported communication application that fully supports both English and Spanish. This software provides built-in vocabulary sets based on age or ability, but offers a special program that allows quick customization to the user. The grid size and buttons can also be modified to fit the user's physical or cognitive function. The user can also replace symbols in the application with personal photographs and create new pages with a template.

Proloquo2go also includes a text-to-speech setting, which allows the user to type a message, rather than touch a symbol. The text-to-speech has configurable word prediction, and there is also an option to use both text and symbols for output. There are several accessibility options for those with motor or visual challenges. These include options for touch control (e.g. hold duration, select on release), auditory fishing and appearance options for vision impairments, and access through Apple's Switch Control, Apple's VoiceOver or Apple Watch (AssistiveWare, 2016),

Bilingual support allows the user to quickly switch between the English and Spanish vocabulary, or mix languages mid-sentence. There is also an option to sync between languages, which allow vocabulary that is updated in one language to be updated in the other. The user can also choose a genuine bilingual girl, boy or male adult for the Text to Speech voice (AssistiveWare, 2016).

LAMP Words for Life is another symbol-grid system application available for iOS. According to the manufacturer, the application was created to use in conjunction with Language Acquisition through Motor Planning (LAMP), a therapeutic approach that uses consistent motor plans for accessing vocabulary. The creators claim that the application provides "a consistent motor pattern for words and a systematic way to develop communication skills allowing for unlimited language growth opportunities." The application also has a pre-programmed vocabulary program, which was created to grow with the child and eliminate the need for extensive customization (AACApps, 2016)

TouchChat HD AAC is an app available for iOS systems and can be purchased alone or with a program called WordPower. The app itself utilizes a symbol-grid system or a text-to-speech system and it supports both English and Spanish. The pages, grid layout, buttons, messages, and symbols within the app are customizable. Buttons can be easily rearranged or copied and pasted into a different location. Page sets are provided, but can be modified to create new custom page sets. The user can also use personal photos or images. Text can also be copied and pasted from other sources and then spoken by the speech generator. Button activation timing can be adjusted to meet the needs and capabilities of the user. Adjustments include button dwell time, button release time, and a setting to activate on release. Users can program buttons to play audio files such as music from the media library or video files from a photo roll. Words, phrases and messages are spoken with a built-in voice synthesizer or by playing back a personal recorded message. Various English and Spanish synthesized voices are available, allowing the user to choose a voice that fits their own personality. TouchChat also has a unique feature that lets the user tilt the device to make the message expand to fill the screen in large letters. This feature allows a person to communicate silently or in a noisy environment (TouchChat, 2016).

The WordPower program contains a series of AAC vocabularies designed by SLP Nancy Inman that range from simple to complex. The more advanced vocabulary sets contain high-frequency core words, spelling and word prediction, category-based pages, and is configured to work with a keyguard and with scanning. The simpler vocabulary sets incorporate carrier phrases with core words for quick and easy language generation and are geared toward individuals with more severe cognitive, visual, and motor impairments (TouchChat, 2016).

GoTalk NOW is an AAC application available for the iPad only. It is a symbol-grid system with a text-to-speech option and a photo story option. With the photo story option, the user can create multimedia social stories and step-by-step instruction. The system can be accessed with touch or a Bluetooth switch. This app also gives the user the option to turn another iPad/iPod/iPhone device into a switch using an additional app called Attainment Switch. GoTalk NOW offers three styles of communication pages: Standard, Scene, and Express. In Standard Pages, the action occurs when the user presses the symbol. Scene Pages are built around a single photo or image. A user can arrange visible or invisible hotspots over people or objects in the photo and can program them to they play speech, music or video. In Express Pages, recorded or text-to-speech are linked in the message bar and played in sequence when the bar is tapped. The pages within the app, size, and colors of buttons are fully customizable. The app provides options to record speech and other audio and incorporate personal photos. One free text-to-speech voice is included. Other text-to-speech voices are available as in-app purchases for 99 cents each in over 20 languages. The application also has several scanning options, which allow the user to select step or auto scanning and adjust the scanning speed. The user also has the option to use group scanning by rows or columns, and can also add an extra auditory cue to announce when the row or column advances. The GoTalk NOW PLUS application contains the same elements as the GoTalk NOW app, but also offers the Symbolstix image library, the Ready-Set-Communicate book which provides a language framework to transition from phrase-based to word- based communication support, and Acapela which offers text-to-speech English voices (Attainment Company, 2016).

TalkingTILES is a touch-access only, symbol-grid application available for iOS systems. The application contains a customizable communication system available in English, German, Northern Sami, and Spanish. The user can choose from a male or female voice or use voice banking which allows an individual to record his or her own voice or a caregiver’s voice. TalkingTILES also includes other programs to support quality of life. On program creates visual schedules that tell the individual what activities will occur and in what sequence. These schedules can be customized to fit the user’s daily activities or common tasks and can be modified based on cognition and ability. The app also has a program to create personal social stories. There are also programs that contain educational and therapy-based content. Data is tracked by a program called Mozzaz Care and can be sent to members of the individual's care team (Mozzaz Corporation, 2016).

Table 3. Applications for tablets

App	Description	Compatible platforms	Cost
Proloquo2go	Symbol-grid system and text-to-speech Access methods: touch, adaptive switch, adjustable direct touch	IOS	$249.99
LAMP Words for Life	Symbol-grid system Access methods: touch	IOS	$299.99
GoTalk NOW	Symbol-grid system, text-to-speech, photo story options. Access methods: touch, adaptive switch	IOS	$79.99
GoTalk NOW PLUS	Symbol-grid system, text-to-speech, photo story options. Access methods: touch, adaptive switch	IOS	$149.99
TalkingTILES	Symbol-grid application system Accessmethods: touch	IOS	
TouchChat HD-AAC	Symbol-grid system or a text-to-speech system Access Methods: touch, adaptive switch, adjustable direct touch, scanning	IOS	$149.99
TouchChat HD-AAC with WordPower	Symbol-grid system or a text-to-speech system Access Methods: touch, adaptive switch, adjustable direct touch, scanning	IOS	$299.99

SELECTING YOUR DEVICE

Given the wide variety of AAC devices available, selecting an appropriate device for a child is a complex and important process. Therapists and families need to consider how the device can be successfully integrated into the child's activities and environments. Evidence suggests there are multiple contributing factors to AAC success. In 2006, Johnson, Inglebret, Jones, and Ray conducted a survey of 275 SLPs who answered a 106-item questionnaire regarding factors for long term AAC success. Respondents ranked the following factors as important to sustained AAC use: 1) the AAC user experiences success with the device, 2) the system is valued by the user and the communication partners, 3) the system is used in an appropriate manner, 4) ongoing training of team members (professionals who work with the AAC user and family members), 5) the AAC system is constantly updated, 6) there are realistic expectations of the AAC user 7) the AAC system is easy to use, and, 8) there is a good match between the AAC user's abilities and the capabilities of the AAC device.

When selecting an AAC device for a child, a team that may include SLPs, occupational therapists, physical therapists, pediatricians, neurologists, parents, family, teachers, and the child themselves should work together to make decisions. This team approach is essential to ensure that the child feels comfortable with the device and is able to use the technology on a daily basis.

The first important decision when choosing a device, is selecting the method of access. The most preferable access options are those that are more natural, direct, and cognitively transparent, such as using the hand to select an item, pointing directly with the head using a head-stick, or eye pointing. Research suggests that direct access methods are preferable to indirect methods because they are easier than scanning, particularly for young children and for children with severe cognitive deficits (Fager, Bardach, Russell, & Higginbotham, 2012). However, when direct methods are not appropriate for the child or are not efficient, the team may try scanning methods of access to AAC devices. The family and team should try out several methods of access to determine the best fit for that individual child, and then make a list of suitable devices and applications. Some devices are manufactured specifically for indirect methods. Many devices can be paired with additional hardware (e.g. switches, eye trackers), to make them more accessible.

Next, the parents and team will want to select the size of the device. The team should consider the environments in which the child will use the device, the child's visual abilities, and physical dexterity. A small device is best suited for a child who needs to communicate in many environments, who can hold the device and use their hands for direct access, and can see the small icons. A large device will benefit children with vision impairments and fine motor impairments, giving them a larger icon to see and activate.

Once these criteria have been decided, the family can work with an SLP to choose a specific device and/or additional hardware (e.g. switches) and software. As previously discussed, the various devices and systems offer an array of languages, voices, pre-set pages and vocabulary,

CUSTOMIZING YOUR DEVICE

Many augmentative and alternative communication devices and apps are now highly customizable. Features that can be personalized include organization, vocabulary content, audio output, and visual appearance. This flexibility allows the device to be tailored to a specific user.

Most AAC systems use symbol-based communication, in which symbols that produce spoken words or phrases when selected are organized into grids or lists. New words and phrases can be added as needed to continuously customize the user's vocabulary. Items can be grouped together topically, to form communication pages and pages can also link to other groups of symbols or pages to provide more extensive organization. This allows caregivers, teachers, and clinicians to personalize the system and quickly respond to changing communication needs (Myrden et al, 2014; Fager et al., 2012; Light & Drager, 2007). .

Complex organizations that require the child to navigate through multiple screens to locate the desired symbol can be overwhelming for the user, especially for young children or individuals with cognitive impairments. ACC layouts that use simple, sequential navigation though communication pages may be more appropriate for these individuals. Layouts that present only two or three symbol options will also be more salient and effective for children with severe physical or cognitive impairments (Myrden et al, 2014; Fager et al., 2012; Light & Drager, 2007). .

Vocabulary content for the device should be chose based on the child's specific needs, interests, and environment. Parents and SLPs should work together to choose content that will be most functional for the child. Vocabulary may include names of important people (Mom, Dad, dog's name, grandma's name), greetings ("Hi, My name is ___, Bye), functional phrases (No, Yes, I'm hungry, I'm thirsty, Bathroom, I'm tired), and interests (sports, animals, holidays) (Myrden et al, 2014; Fager et al., 2012).

Voice output can also be customized on AAC devices. A family can choose from a variety of realistic synthetic voice options, or some devices that give the option of recording voice output. Some systems or apps even offer affective and expressive variants of the same voice, such as happy and sad or whining, whispering and shouting speech output alternatives. The primary focus when using an AAC device should be on strengthening functional communication, and all customizations should be implemented with this goal in mind (Myrden et al, 2014; Fager et al., 2012; Light & Drager, 2007).

Chapter Four: Conclusions

Recommendations for Using the Guide

It is not recommended that a parent use this guide on his or her own. Rather, a parent should read and refer to this in conjunction with consulting with members of the child's educational team. The team may include SLPs, occupational therapists, physical therapists, doctors, teachers, and others. This guide will help a parent understand the options and the technology when speaking to professionals in the healthcare field. After reading this guide, a parent will have the information necessary to weigh in on AAC decisions for their child and functionally use the device at home.

Summary

There are many types of AAC that may benefit children with communication impairments. These range from simple methods like a picture exchange system to SGDs that can generate 1-100s of spoken messages. The current literature on SGD use for children is extensive, covering various populations of children, communicative functions, and devices. There are numerous SGDs available today that offer endless variation and customization. It is important for parents and the child's team of other professionals to examine all of the options before paring a device with a child. Furthermore, these devices must be customized in order to optimally fit and assist the child. Parents can use this guide as they consult with the child's SLP to gain knowledge on available SGDs and how the devices may benefit their child.

Future Research

Future research needs to study SGD use for children in both larger and more specific ways. New studies should examine larger sample sizes rather than comparing only a handful of children. The literature also needs to include more types of SGDS rather than giving focus to the iPad. Similarly, studies should evaluate applications beyond Proloquo2go. Future research should also concentrate on maintenance and generalization after intervention. Few current studies conduct a follow-up period to determine if improvement continued after initial SGD training and intervention. Overall, research is promising that SGD use can improve communication in children with severe communication deficits.

CONCLUSIONS

SGDs can provide effective, evidence-based intervention for some children with communication deficits. There are a variety of devices and options available, some of which are covered in numerous research articles. Gathering and processing this information, especially as a parent can be overwhelming. With this paper as a guide, parents can advance their knowledge in this area of intervention and equip themselves to work with their child's SLP. Together, they will not only select a device that will promote the child's communication, but personalize it so that the child and the family at home can increase their quality of life.

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