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Finding the Words: The Impact of VOCA on Language Acquisition

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FINDING THE WORDS: THE IMPACT OF VOCA ON LANGUAGE ACQUISITION

BY

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ABSTRACT

The current study researches the impact of voice output communication aids (VOCA) on the language acquisition of toddlers and school-aged children with developmental disabilities. There are a wide variety of augmentative and alternative communication (AAC) devices available to nonverbal individuals, making the decision of parents, teachers, and speech pathologists of which to use and implement a substantial task, one that needs the guidance of research based evidence. SPSS software was used to conduct a series of analyses with secondary data from Nancy Brady's study *Language Development of Non-verbal Children Age 3 Years through 7 Years, 2007 to 2012*, looking specifically at the increase in total words rate of children using various AAC interventions over a year's time. Total words rate scores were determined using the number of different words each child spoke, signed, or selected during observations and assessments completed by researchers. A multitude of T-tests and a multiple regression equation were run, comparing the outcomes of participants based on their use of a VOCA and presence of an autism diagnosis. Results found participants using other forms of augmentative communication to have a higher total words rate at time 2 than those using VOCA, though these findings were not significant. Gender and autism were not found to be significant predictors of language acquisition, though being male was positively correlated with total words rate scores. Analyses also concluded that participants with an autism diagnosis using VOCA had a slightly higher total words rate at time 2 than those with other developmental disabilities using VOCA, though these findings were also not significant. Future research should consider looking at a randomly selected sample with a wider

quantitative range of expressive vocabulary, as well as obtaining the identification of the type and severity of a child's diagnosis to further clarify the evidence-based benefits of VOCA with specific populations.

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INTRODUCTION

Parents, teachers, and speech-language pathologists of nonverbal children utilize therapy strategies and scaffold surrounding interactions in an attempt to expand repertoires of communication skills, work on new vocabulary, build up the length of syntax, and/or implement alternative means of expression in cases that the learned language is not capable of being physically spoken (Mirenda, 2003). These supplemental means of expression, called augmentative and alternative communication (AAC), allow individuals with not only autism but all types of developmental disabilities to express their thoughts, needs, wants, and ideas (American Speech-Language-Hearing Association, no date). Often times, AAC can even encourage and nurture verbal language, utilized by children as a temporary means of communication rather than a permanent solution.

Delays in receptive and expressive language are common amongst toddlers and school-aged children diagnosed with developmental disabilities (Branson & Demchak, 2009). Individuals with developmental disabilities who remain nonverbal throughout their lifespan commonly develop subsequent behavioral problems as a result of difficulties with communication, resorting to maladaptive actions like aggression and self-injury to get their needs met (Morgan, Farkas, Hillemeier, & Hammer, 2015). Being able to provide this population with a means by which to communicate and help their caretakers, teachers, and therapists better understand and address their challenges is imperative and beneficial to all involved. The purpose of the current research will be

to investigate one specific means of AAC, voice output communication aids (VOCA), also know as speech generating devices (SGD), looking at their impact on the language acquisition of toddlers and school-aged children with developmental disabilities in comparison to other AAC interventions.

REVIEW OF LITERATURE

Toddlers and school-aged children diagnosed with developmental disabilities frequently encounter delays in receptive and expressive language that are either overcome or continually managed throughout their lifespans (Branson & Demchak, 2009). Often times, these language delays, or delays in areas like social-emotional, adaptive, and/or cognitive skills, are what initially signal to doctors, early intervention specialists, and/or parents the possibility of a future developmental disability diagnosis (Solomon-Rice, 2010).

Children typically develop first words and phrases around 12-18 months of age. By age 3, most children have words for almost everything, stringing together two or three words when interacting with others. Between the ages of 3 and 4, children should start using pronouns and plural words, putting simple sentences together to talk about events and answer questions. By age 5, a typically developing child should be able to say all speech sounds in words with minimal mistakes limited to more complex pronunciation, talking in sentences while maintaining conversation with a partner (American Speech-Language-Hearing Association, no date).

Signs possibly indicating language problems include making only a few sounds and not using gestures, like pointing, by 12 months of age, saying only a few words at 18 months of age, not putting two words together by 2 years of age, saying fewer than 50 words at 2 years of age, and having trouble playing and talking with other children at 3 years of age (American Speech-Language-Hearing Association, no

date). As with all domains of development, milestones vary child to child and should be used as loose guidelines for parents and caregivers of children (American Speech-Language-Hearing Association, no date).

Factors Related to Language Acquisition in Toddlers and School-Aged Children: Autism and Gender

Children with developmental disabilities have an array of cognitive, communicative, social-emotional, adaptive, and/or motor delays. There are three major markers for autism spectrum disorder (ASD) specifically, a developmental disability emphasized in the current study: deficits in social communication, deficits in social interaction, and the presence of restricted, repetitive behaviors (American Speech-Language-Hearing Association, no date). Two of these markers, social communication and social interaction, piggy back on the language abilities of individuals diagnosed with ASD, both receptive and expressive. About one in sixty-eight children is identified with ASD, making it a prevalent developmental disability affecting the lives of a large portion of society (Centers for Disease Control and Prevention, 2018). A lack of ability to communicate is often the cause of frustration and consequential problematic behaviors for children with developmental disabilities (Morgan et al., 2015), making figuring out an efficient tactic to promote the language development of this population a necessary, preventative measure the field of human development and aligning professional disciplines should advocate for and invest in.

Individuals with ASD have been observed to acquire expressive language even after age 5, but very few children begin to speak after middle childhood (NIH, 2010). The atypical developmental trajectory of this population coincides with delays in

multiple domains as noted earlier, pushing milestone markers to later dates, asking professionals to readjust their age appropriate expectations and continue utilizing teaching methods associated with success in early childhood. In a study by Wodka and colleagues (2013), which focused on a sample of 535 children with ASD who were at least 8 years of age and had not acquired phrase speech before age 4, 70% of participants attained phrase and/or fluent speech by age 8, with almost half of the sample achieving fluent speech, showcasing the potential of delayed language learners.

Intellectual disability (ID) is characterized by significant limitations in intellectual functioning (e.g., reasoning, learning, and problem solving), significant limitations in adaptive behavior (i.e., conceptual, social, and practical skills in everyday life), and an onset in childhood (before 18 years of age) (American Speech-Language-Hearing Association, no date). ID is a subset of developmental disability (DD), which is defined as a severe, chronic disability in an individual 5 years of age or older, with an onset before 22 years of age, that results in substantial functional limitations in three or more areas of life activity (self-care, receptive and expressive language, learning, mobility, self-direction, capacity for independent learning, economic self-sufficiency) (American Speech-Language-Hearing Association, no date). ASD can co-occur with ID, though it is classified as a developmental disability (American Speech-Language-Hearing Association, no date).

Research evidences developmental differences between females and males, including neurological variations that can affect related functional and academic skills. Jensen (2015) discusses some of these variations in regard to language development,

writing “girls’ language development, specifically reading and writing, is generally about one to one and a half years ahead of boys.” Huttenlocher, Haight, Bryk, Seltzer, and Lyons (1991) found child gender to be associated with early differences in language capacities, suggesting the amount of parent speech modeled for children after 20 months to be a more important variable pertaining to later vocabulary growth. These findings implicate the dissipation of gender differences in language acquisition around age 3.

Aided Communication Systems

For language delays in particular, speech pathologists evaluate and assess a child to determine the best course of intervention and treatment (Dyches, 2001). Part of this process is choosing which AAC devices will most benefit each individual client and support individual language acquisition. Many individuals with developmental disabilities are candidates for AAC systems, either to supplement (i.e., augment) their existing speech or to act as their primary (i.e., alternative) method of expressive communication (Mirenda, 2003). Augmentative and alternative communication devices (AAC) are all forms of communication (other than oral speech) used to express thoughts, needs, wants, and ideas. There are two types of AAC: aided and unaided. Aided communication systems require the use of tools or equipment to convey a message, while unaided communication systems rely primarily on a user’s body (American Speech-Language-Hearing Association, no date). Examples of aided communication systems include picture exchange communication system and voice output communication aids, also known as speech generating devices, the AAC

intervention explored in the current study. Examples of unaided communication systems include physical gesturing and sign language.

Research on the effects of AAC intervention pertaining to children under the age of three and/or those with a developmental disability is limited which, in part, may be due to first words and phrases typically emerging around 12-18 months (Morgan et al., 2015). Available literature focused on AAC intervention with older age groups frequently is limited by small sample sizes and lack of comparison groups determined by age, diagnosis, severity of delay/disability, type of AAC device, baseline language abilities, etc.

There are three primary aided communication systems used with children with developmental disabilities: picture communication symbols (PCS), picture exchange communication system (PECS), and voice output communication aid (VOCA). Picture communication symbols are derived from a software program called BoardMaker. Children use the pictures to communicate thoughts, needs, wants, and ideas through images typically consisting of different foods, activities, and places. BoardMaker pictures are universally recognized and frequently used in PECS programs as well. The picture exchange communication system uses behavioral principles and techniques to teach children functional communication using pictures (Charlop-Christy, Carpenter, Le, LeBlanc, & Kellet, 2002). It has six "levels", each targeting a different communication skill. PECS programs require books lined with Velcro to organize the picture sets with a sentence board on the front cover for a child to initiate requests, respond to questions, and make social comments.

The final aided communication system to be discussed, voice output communication aids (or speech generating devices) [the AAC devices studied in this research], require the use of electronics—currently, iPads with downloaded speech device applications are a popular choice of VOCA for parents with a nonverbal child. VOCA allows children to respond to open-ended questions in short sentence form by pressing pictures (often from BoardMaker) on their electronic devices, which the VOCA simultaneously vocalizes. The added bonus of VOCA is the therapeutic reinforcement of targeted vocabulary. VOCA are constantly prompting their users as they say words at a slower speech rate with an increased emphasis/stress, a technique used by speech pathologists and suggested to parents during therapy sessions (Solomon-Rice & Soto, 2014).

Use of VOCA with Toddlers and School-Aged Children with Developmental Disabilities

The preliminary studies, looking at the effectiveness of VOCA with toddler and school-aged children, follow a consistent theme, reinforcing that children with developmental disabilities need more intense and longer duration of intervention relating to language delay/impairment (Solomon-Rice, 2010 & Solomon-Rice et al., 2014). Scholarly articles find aided communication systems to have a greater impact on the language acquisition of children with cognitive impairments than unaided systems, though most studies contributing to the literature have small sample sizes and lack comparison groups based on age, diagnosis, severity of delay/disability, type of AAC device, baseline language abilities, etc. (Moore & Calvert, 2000, Branson & Demchak, 2009, & Solomon-Rice, 2010). There is considerable research suggesting

that individuals with ASD generally do not experience deficits in discrimination learning, especially when the stimuli are concrete in nature (e.g., BoardMaker pictures) (Mirenda, 2003). Discrimination learning is the basis of VOCA, users needing to make connections between the motivation to communicate, graphic symbols and subsequent technology-based vocalizations, and message recipients. Individuals with ASD typically maintain strong visual-spatial learning abilities, keeping associated skills, such as symbol recognition and recall memory, intact, making it more likely that they will find it easier to learn aided systems than manual sign, especially with the added bonus of the immediate speech production of VOCA devices upon picture selection (Mirenda, 2003).

Solomon-Rice and Soto (2014) studied and compared the use of focused stimulation and augmented input as intervention methods with 3 children with severe communication difficulties and developmental delays. The keywords of focused stimulation are target vocabulary and grammatical markers, returning to that noted therapeutic strategy of saying words at a slower speech rate with increased emphasis. Speech pathologists prompt a child simply by setting up a social interaction or developmentally appropriate activity that will allow the targeted vocabulary to be used multiple times in a natural way. Augmented input pulls in those extra variables of graphic symbols and signing, notably beneficial and stimulating as well (Solomon-Rice et al., 2014). Solomon-Rice and colleagues (2014) found both focused stimulation and augmented input to improve the expressive vocabulary of the three participants who were each communicating via multi-modal AAC consisting of a combination of unaided and aided systems at the beginning of the study, supporting

the use of VOCA to facilitate language acquisition, as these devices combine both evidence-based intervention methods. It is important to note that these findings originate from a study that only included three participants; however, this allowed researchers to monitor and record the progress of each child thoroughly, adding to the limited scope of evidence-based knowledge pertaining to the facilitation of vocabulary with toddlers using AAC.

Mirenda (2003) compares speech and manual signing to aided communication across all age groups and participant populations, summarizing the findings of a multitude of literature focused on these alternative methods and their connection to successful language acquisition. Those supporting speech and sign argue associated discrimination is less complicated because it involves only a single stimulus and response (2003). For instance, a child can manually sign the word cup (stimulus) to which a parent will respond by bringing over the desired item (response) (Mirenda, 2003). Aided communication systems have multiple stimuli, including the need for a physically present symbol of a cup and the motivation to scan and select a field to find the appropriate symbol. As argued above, other researchers stand by the argument that speech and manual signs require the cognitive processes of recall memory and physical effort and coordination (Mirenda, 2003). Though aided communication systems still require some level of memorization and symbolic understanding, the pictures have a strong resemblance to their referents and are easier to learn and remember than speech and sign, which are more abstract language components.

Moore and Calvert (2000) compared teacher and computer instruction to see which most benefitted the language acquisition of children with ASD ages 3 to 6.

Findings revealed the children were more attentive, recalled more nouns, and were more interested in continuing treatment with computer-based instruction (Moore & Calvert, 2000). Though this study does not address VOCA specifically, its results should be considered when looking at the field of alternative and augmentative communication, as VOCA is the only method of AAC that is technology-based.

Schepis, Reid, Behrmann, and Sutton (1998) looked at the use of VOCA with four children with ASD in a self-contained classroom ranging in age from 3 to 5. Results supported the integration of VOCA usage in naturalistic teaching methods to increase communicative behaviors (Schepis et al., 1998). Training on naturalistic teaching procedures, which involve the use of naturally occurring opportunities to teach communication skills during the course of an individual's daily routine, and introduction to VOCA led to increased communicative interaction between classroom staff members and the study participants (Schepis et al., 1998). Olive and colleagues (2007) similarly studied three children with ASD ages 3-5 in classroom settings. They found aligning results, which supported the use of VOCA alongside enhanced milieu teaching, a naturalistic communication intervention that emphasizes adult prompting and natural reinforcement through child-led activities (Olive, Cruz, Davis, Chan, Lang, O'Reilly, & Dickson, 2007). Additionally, Olive and colleagues stress the brevity of their intervention methods, averaging only 5 minutes a day over the course of 19 intervention sessions. This indicates the ease of implementation of VOCA as a method of AAC intervention, a positive for caretakers, teachers, and therapists of children with language delays and disabilities as timely and complicated strategies may be less likely to be consistently implemented over an extended period of time.

Branson and Demchak (2009) conducted a research review focused on the current literature regarding the use of AAC methods with infants and toddlers with developmental disabilities. They found conclusive evidence in seven studies that indicated AAC methods to be effective with infants and toddlers, leading to an improvement in communication skills following the intervention (Branson & Demchak, 2009). These seven studies provided evidence of benefits for children across disabilities (autism, cerebral palsy, Down syndrome, intellectual disability not associated with Down syndrome, and unspecified developmental delays), using both unaided and aided communication systems. Branson and Demchak (2009) note that only two of the studies they reviewed compared AAC methods, making additional evidence-based studies necessary for drawing conclusions about different intervention methods and their impact on the communication of children with specific disabilities.

Another specific diagnosis present in the participant sample used in the current study is Down syndrome. Branson and Demchak (2009) specifically note a study done by Iacono and Duncum in 1995, which compared the use of manual signs alone to the simultaneous use of manual signs and a VOCA with a 32-month-old girl with Down syndrome. The child in their study produced more words and a larger variety of words in the later condition, lending evidence to the benefits of VOCA, whether used alone or in combination with other methods of AAC intervention.

Though Jensen's research on gender differences in language skills is mostly surrounding the adolescent age group, there are key considerations related to the use of augmentative communication (2015). When given complex auditory and visual language tasks, the activated areas of females' brains were associated with abstract

thinking through language, while accuracy of completion for the males depended on their senses of hearing and sight (Jensen, 2015). This implies the importance of symbolic understanding for females and physiological functioning for males. Though all individuals need healthy auditory and speech mechanisms for optimal communication abilities, there is science linking specific components of VOCA as more beneficial depending on gender. The pictures used on the VOCA, whether they are digital or Mayer-Johnson (downloaded using the Boardmaker Software), may be more influential in determining progress made in terms of language understanding and acquisition for females, while the speech generated, spoken aloud by the device after a picture has been selected, may be the component of more weight for males.

The current study will utilize Vygotsky's social constructivist theory which roots all cognitive processes in social interactions as each function in the child's development appears initially at the social level and eventually is internalized (Vygotsky, 1978, & Solomon-Rice, 2010). Effective use and mastery of VOCA, the AAC device that will be investigated in the current study, relies on adult modeling and scaffolding, components of social constructivist theory. The "zone of proximal development" (ZPD) is the "distance" between what the child is able to do by him or herself and what he/she is able to do with the support of an adult. Specific to language development, adults supply communicative meaning to a child's actions and guide the child in negotiating meaning and expressing him/herself (Solomon-Rice, 2010). In terms of AAC, the supporting adult would need to scaffold a child's language using the chosen device to model how this alternative method of communication should be used. Adults need to be as sensitive and responsive to words produced using an AAC

as they would be to spoken language in order to reinforce language acquisition and appropriate implementation so children make necessary connections.

Huttenlocher et al. goes on to explain that the acquisition of a large number of vocabulary items learned later on may depend more on the number of presentations of particular words (learning trials), touching on one of the advantages of VOCA usage, consistent word articulation and repetition, whether a parent or guardian is available for communication modeling or not (1991). In terms of gender differences regarding language acquisition, this could project a necessary overall shift in scaffolding methods for typically developing children once they near two years of age. As for children with developmental delays and disabilities, the combination of both symbolic and auditory reinforcement may present as more beneficial, allowing communication connections to be made on two different levels in two different ways. As parents, educators, and professionals working with children with language delays and disabilities, it is necessary to remain mindful of potential learning differences and differing developmental trajectories, like the "small but consistent female advantage" in early language development (Wallentin, 2009).

This study looks specifically at autism and gender as predicting variables of language acquisition from the use of VOCA. It should be noted that the male to female diagnostic ratio for ASD is approximately 3 to 1, lending itself to the assumption that more males will require augmentative communication services than females in terms of this population (Wallentin, 2009). As a distinguishing feature of ASD is language deficiency (e.g., muteness, language delay, echoing of speech, and idiosyncratic use of language), most individuals with a diagnosis will need some sort of speech therapy at

one point or another and any neurological gender differences are important to note and keep in mind when developing strategies for functional communication.

Summary

In summary, there is a gap in the research when looking specifically at the impact of AAC devices on the language acquisition of children diagnosed with ASD and other developmental disabilities. Available literature focused on AAC intervention is limited by small sample sizes and lack of comparison groups determined by age, diagnosis, severity of delay/disability, type of AAC device, baseline language abilities, etc. The current study will address two questions specifically: 1) What impact do voice output communication aids have on the language acquisition of young children with developmental disabilities?; and 2) Do gender and/or autism influence the relationship between voice output communication aids and language acquisition? It is hypothesized that VOCA are more beneficial to the language acquisition of children with developmental disabilities than other methods of alternative and augmentative communication. The logic for this hypothesis relates to that of a therapy strategy implemented by speech pathologists, particularly in Early Intervention: modeling (Dyches, 2001). Dyches explains that one of the best and most natural ways to expose children with language delays to appropriate communication is simply by using it in front of them. This is how typically developing children acquire language as well, observing and hearing their parents and caretakers reciprocally communicate with others. While VOCA are not people, they have one component that graphic symbols and sign language, other commonly used types of AAC, do not: digitized speech, which models verbal language for users. Having access to both the visual

representation of pictures with their corresponding written labels and vocalized selections would seemingly make VOCA a powerful tool for a population in need of consistent reminders and reinforcement regarding positive social communication and interaction.

This study will also compare the language acquisition of male and female children and those with an ASD diagnosis versus those without in relation to VOCA instruction to examine the effectiveness of these aided systems with different populations. Children with developmental disabilities can take longer to learn how to vocalize their thoughts, needs, wants, and ideas. Social-emotional, adaptive, and cognitive delays are often partnered with the language impairments of these populations (Thurm, Lord, Lee, & Newschaffer, 2007). Researching which AAC devices have been most effective in increasing the expressive language skills of children with developmental disabilities, along with tracking the time period of implementation and duration of therapy, are important next steps in this field. Giving children with developmental disabilities a better chance to access their words and use them in a communicative manner will reduce the likelihood of consequential problem behaviors that result from frustrations around an inability to convey messages.

METHODS

Procedures

The data for this study is derived from Nancy Brady's study, *Language Development of Non-verbal Children Age 3 Years through 7 Years, 2007 to 2012*, access granted via the Inter-University Consortium for Political and Social Research (ICPSR). Ninety-three preschool children with developmental disabilities were assessed at Time 1, and 82 of these children were assessed one year later at Time 2. Brady collected data using six different language assessments at two points in time. These language assessments are as follows: Communication Complexity Scale, Design to Learn, Early Childhood Environment Rating Scale, Mullen Scales of Early Learning, Peabody Picture Vocabulary Test, and Preschool Language Scale. Brady's study researches the effects of Voice Output Communication Aid on the symbolic communication of non-verbal children ages 3 through 7.

Sample

School districts in and near the Kansas City metropolitan area, specifically, in Topeka, Kansas, and Wichita, Kansas were contacted when recruiting the study sample. Teachers and speech-language pathologists nominated children meeting the study's eight criteria for individual participation: (a) chronological age between 3 and 5 years; (b) enrollment in a preschool program; (c) vision reported as 20/80 or better in at least one eye (with or without correction); (d) hearing reported as 25 dB HL or better in at least one ear (with or without amplification); (e) upper body motor skills sufficient to directly select symbols with fingers, hands, or arms; (f) English as the

primary language spoken at home; (g) current teaching plans that included AAC (graphic symbols, sign language, and/or and SGD); and (h) vocabularies of fewer than 20 different words said, signed or selected. To determine if children met the final criteria, parents and teachers were asked to list words produced spontaneously (without prompting), intentionally (directed to another person), and intelligibly. Once children were selected, their parents were contacted to gain informed consent and complete the screening and assessment process. Ninety-three children qualified for the initial assessment, eighty-two of those participants completing a second assessment a year later. For the current study, participants were only included if they completed assessments at both dates as follow-up scores were necessary to answer the research questions addressed here. Frequencies were run to assess the demographic information of those removed in comparison to the remaining participants. All participants removed were male, half with an ASD diagnosis, nine white, and only one using VOCA. The outcome variable was the number of words the participants produced with speech, sign language, and/or a speech-generating device at time 2.

Independent Variable

Voice Output Communication Aid (VOCA)

For the purpose of the current study, voice output communication aid will serve as the independent variable for the first research question: What impact do voice output communication aids have on the language acquisition of young children with developmental disabilities? Voice output communication aid, is defined as an electronic device that produces verbal output for individuals unable to speak. VOCA is

a categorical variable, which is coded as either yes or no in regard to a participant using this specific form of AAC device. This data were parent-reported.

Predicting Variables

Autism

The autism variable will be added in as a predicting variable in order to answer the second research question: Does autism impact the association of voice output communication aids with language acquisition? Autism is also coded categorically, with participants assigned a numerical value based on whether or not they have a diagnosis. These data were parent-reported.

Gender

The gender variable will also be used as a predicting variable to determine whether this demographic characteristic influences language acquisition using VOCA. Gender is coded categorically (e.g., female or male) and is parent-reported.

Covariates

Descriptive statistics such as age in months at enrollment and race were assessed as possible covariates in the multiple regression equation. These demographic variables are coded categorically and were parent-reported: age in months at enrollment (e.g., 36 to 42 months, 43 to 48 months, 49 to 54 months, 55 to 60 months, or 61 or more months) and race (e.g., black, white, or other). Though age in months at enrollment is coded categorically, it will be used as interval data in the current study. Race was recoded into two categories: white and other.

Dependent Variable

Total Words Rate Time 2

Data for the variable total words rate at time 2 were collected using six different language assessments. These language assessments are as follows: Communication Complexity Scale, Design to Learn, Early Childhood Environment Rating Scale, Mullen Scales of Early Learning, Peabody Picture Vocabulary Test, and Preschool Language Scale. The number of different words the children produced (with speech, sign, or speech generating devices) was recorded by researchers based on observations and assessment scores. As one of the criteria for participation was a vocabulary of fewer than 20 different words said, signed or selected, previous researchers classified all children as nonverbal, making their time 1 data a quantitative score of zero. The original data analysis plan involved a paired samples T-test, which would identify the change between time 1 and time 2 for the core sample with available data for both assessments, but had to be changed to an independent samples T-test upon further cleaning of the dataset.

Data Analysis

Data analyses were conducted using SPSS software. Descriptive statistics and frequencies were conducted in order to assess the gender, age in months at enrollment, and race of all participants. These initial analyses also look at the presence of an ASD diagnosis and usage of VOCA for each participant. A contingency table was conducted to determine if the demographic groupings of participants using VOCA and those using other forms of AAC were similar. In order to compare the impact of VOCA versus other AAC devices on the language acquisition of children with developmental disabilities, an independent samples T-test was conducted looking at the difference in total words rate at the time 2 assessment for both groups, which was

determined by the recorded use of VOCA in the dataset. Next, a multiple regression equation was used to predict the strength of the relationship between VOCA and expressive language by assessing whether ASD diagnosis or gender mediates this relationship, controlling for significant demographic differences between the VOCA and non-VOCA groups.

RESULTS

The first analyses conducted examined participant demographics for those with available data at time 1 and time 2. Table 1 describes the final study sample consisting of eighty-one children with an average age of 46 months (3.8 years). Age and race were not found to be significant and therefore were not controlled for in the multiple regression equation, as the VOCA and non-VOCA groups were demographically similar. A large percentage of the included sample is male and white, however the presence of an ASD diagnosis or lack thereof was almost evenly split for both groups. Just under half of the sample used a VOCA, with the rest of the sample using some other kind of augmentative communication. Participant demographics were all within the -3 to +3 range in regard to skew, supporting normal distribution of the tested population.

Table 1. Statistics of Descriptive Sample (n=81)

Demographics	%(n)	%(n)	t-x^2
	VOCA (n=34)	NON-VOCA (n=47)	
Age			.070
36 to 42 Months	35.3(12)	25.5(12)	
43 to 48 Months	8.8(3)	31.9(15)	
49 to 54 Months	14.7(5)	17.0(8)	
55 to 60 Months	20.6(7)	19.1(9)	
61+ Months	20.6(7)	6.4(3)	
Gender			.586
Female	26.5(9)	21.3(10)	
Male	73.5(25)	78.7(37)	
Race			
White	75.8(25)	74.5(35)	.896
Other	24.2(9)	25.5(12)	
Autism			.320
Yes	44.1(15)	55.3(26)	
No	55.9(19)	44.7(21)	

Next, an independent samples T-test was conducted to compare the total words rate at time 2 of the participants using VOCA versus those using other forms of augmentative communication. Participants using other forms of augmentative communication had a higher overall mean score for total words rate at time 2 (m=43.09, SD=3.29) versus participants using VOCA (m=34.74, SD=4.44). The difference was not significant, p=.127, t(79)=1.543.

A hierarchical linear regression analysis was conducted to predict the overall total words rate scores at time 2 from use of VOCA, presence of an ASD diagnosis, and gender. The results of this analysis indicated that none of these variables account for a significant amount of participants' total words rate scores at time 2.

Table 2. Hierarchical Linear Regression Analyzing VOCA Usage, Presence of Autism, and Gender as Predictors of Total Words Rate (n=81)

	Model 1			Model 2			Model 3		
Variable	*B*	*SE B*	*B*	*B*	*SE B*	*B*	*B*	*SE B*	*B*
Uses VOCA	-8.350	5.411	-.171	-8.894	5.451	-.182	-8.819	5.486	-.181
Has Autism				-4.862	5.381	-.101	-5.272	5.529	-.109
Male							2.342	6.496	.041
R^2 Change		.029			.010			.002	
F Change		2.381			.817			.130	
Sig. F Change		.127			.369			.719	

Findings were not significant.

Finally, an exploratory analysis was conducted to compare the total words rate at time 2 of the participants using VOCA with an ASD diagnosis and those using VOCA with other diagnoses, comparing the benefits of the AAC intervention studied in this research for the language acquisition of specific populations. A second independent samples T-test indicated that both groups had similar means for total words rate at time 2, with participants with ASD scoring only slightly higher (m=35.67, SD=22.08) than those with alternate diagnoses (m=34, SD=29.16). It is important to note the sizable standard deviation of both groups. These findings were not significant, p=.856, $t(32)$=-.184.

Table 3. Exploratory Independent Samples T-test of VOCA Participants (n=34)

	AUTISM DIAGNOSIS total words rate *m*(*SD*)	OTHER DIAGNOSIS total words rate *m*(*SD*)
Time 2	35.67(22.08)	34(29.16)

Differences were not significant.

DISCUSSION

Contrary to the hypothesis, the findings of the first independent samples T-test indicate a slightly higher total words rate at time 2 for those participants using forms of augmentative communication other than VOCA, though this difference was not significant. Findings correlate with a number of previous studies concluding various types of AAC are all effective in increasing expressive vocabulary. Solomon-Rice and Soto (2014) studied the effect of two intervention methods, focused stimulation and augmented input, on the expressive vocabulary of three children between ages 2 and 3. Augmented input involved the interventionists modeling the use of the child's AAC system (e.g., by pointing to the graphic symbol on the child's AAC system, or signing), whereas focused stimulation used verbal modeling of targeted words alone (Solomon-Rice et al., 2014). This research indicated both treatment methods to be effective in facilitating more rapid vocabulary production for participants, providing a practice-based example of the theoretical framework of the current study—social constructivist theory—and the concepts of scaffolding and the zone of proximal development, which rely on adult support in terms of skill acquisition in children.

Branson and Demchak (2009) suggest a variety of AAC methods can be effective when caregivers respond consistently and contingently to their children's communication attempts, indicating that communication systems should be implemented in order to increase a caregiver's ability to recognize and respond to a child. Vygotsky's social constructivist theory, which roots all cognitive processes in social interactions, would emphasize the importance of choosing an AAC device that

best supports ease of communication to allow for optimal socialization between members of a particular context, especially the individual with the language impairment. All forms of alternative and augmentative communication rely on adult modeling and scaffolding, components of social constructivist theory, during initial implementation and throughout learning until mastery is achieved, an additional point that must be considered in connection with the non-significant findings of this study. The initial hypothesis assumed the social constructivist theory would support VOCA intervention because of the modeling and scaffolding provided by speech generating devices. The findings, however, may suggest the need to weigh more importance on the modeling and scaffolding provided by adults in combination with the support of the AAC intervention.

Instead of focusing on the interaction of a child with an AAC intervention, research should look at the interaction of a child with an AAC intervention and the adult supporting its use. Parents, teachers, and therapists of children with developmental disabilities need to think about their availability in terms of prompting and responding. Adults must supply communicative meaning to a child's actions and guide the child in negotiating meaning and expressing him/herself (Solomon-Rice, 2010). Aided communication systems may require more attention on behalf of caretakers when taking into account the multiple stimuli Mirenda (2003) discusses. Adults are responsible for keeping these aided communication systems in good condition and making them available to children at all times allowing for continuous opportunities for communication and interaction. Adults need to be as sensitive and responsive to words produced using an AAC as they would be to spoken language in

order to reinforce language acquisition and appropriate implementation so children make necessary connections. The current body of literature pertaining to AAC methods used with toddlers and school-aged children does not focus on this potentially mediating or predicting variable of parent involvement, but rather the direct relationship between intervention strategies and language acquisition.

Considering the social constructivist theory, parents, teachers, and therapists must choose AAC intervention methods while simultaneously thinking about the "zone of proximal development" (ZPD): the "distance" between what the child is able to do by him or herself and what he/she is able to do with the support of an adult. Successful implementation of AAC requires commitment and comprehension in terms of the adults who will procure associated therapy strategies and mediate related interactions.

Another possible explanation for why findings do not confirm the initial hypothesis could be that those using VOCA have more significant developmental disabilities than those using other communication methods. Considering the level of support provided by VOCA, across both visual and auditory modalities, it is likely teachers and speech-language pathologists would use this means of communication with children needing more intensive support. Children with more mild to moderate developmental disabilities are more probable to use unaided communication systems due to the likelihood of them being at a higher level of mastery in neighboring areas of development (e.g., the motor and cognitive domains). Though the VOCA and non-VOCA groups had minimal differences between them and a similar distribution of

participants with ASD, the severity of developmental disabilities of both groups is unknown, which could explain the lack of significance of the current findings.

A hierarchical linear regression revealed no significance of use of VOCA, presence of an ASD diagnosis, or gender as predictors of language acquisition. Huttenlocher et al. (1991) found gender effects in acquisition of new words to already be declining at 20-24 months of age. Wallentin (2009) reiterates the presence of a small but consistent female advantage pertaining to early language development, noting that this seems to disappear during childhood and is not readily identifiable in adults. After the 20-month marker, parent speech becomes a heavier predictor of language acquisition, again emphasizing the importance of adult interactions with children working to expand their vocabulary and subsequent communication skills (Huttenlocher et al., 1991). Considering the older age and heavily weighted male sample of the current study, the lack of significance of gender as a predictor of total words rate correlates with available literature, any potential associated differences likely to dissipate by toddlerhood.

Wallentin (2009) discusses the skewed sex distribution of ASD, the male to female ratio being approximately 3 to 1, linking this statistic to the language function of diagnosed individuals. Many children with ASD who present with severe language delay can be expected to make notable gains in the development of language after age 4, which potentially explains the lack of significance of ASD as a predictor of language acquisition in the current study (Wodka, Mathy, & Kalb, 2012). Phrase and/or fluent speech was achieved by the majority of participants in Wodka and colleague's study by 8 years of age (2012). The sample used for this research ranged

from 3 to 7 years of age, with a total of 82 participants of which only 41 were diagnosed with ASD, while Wodka studied 535 children with ASD, who were all at least 8 years of age. Additionally, though the current study was longitudinal, it only lasted a year in duration, which could also explain the insignificant findings as progress with language with children with developmental disabilities can vary drastically during the early childhood years (Wodka et al., 2012).

An exploratory analysis indicated a higher total words rate at time 2 for those participants with an ASD diagnosis who use VOCA versus those with other developmental disabilities who use VOCA, though this difference was not significant. There is considerable research suggesting that individuals with ASD typically do not experience deficits in discrimination learning, especially when the stimuli are concrete in nature (e.g., BoardMaker symbols and digital pictures) (Mirenda, 2003). This would support the use of aided communication systems, like VOCA, with the ASD population, as this form of AAC intervention is less abstract and more aligned with the learning style of these individuals, allowing a strengths-based approach to language acquisition. Mirenda (2003) reiterates that cognitive scientists would argue any discrimination that requires recognition (e.g., the graphic symbols on a communication display) rather than recall memory (e.g., manual signs) is easier to achieve because fewer cognitive resources are involved. Aided communication systems also allow ease of motor planning, a child simply needing to gesture to or point at a picture to express his/her thoughts, needs, wants, and ideas. It is unlike the complex motor planning needed for sign language (Branson & Demchak, 2009).

Deficits in social communication and interaction are two markers of ASD, making communication impairments lifelong challenges for the majority of diagnosed individuals (American Speech-Language-Hearing Association, no date). Progress with language acquisition for the ASD population may be slow, achievements made gradually over an extended period of time. Picture Exchange Communication System (PECS) is another common AAC device used with children with ASD across settings, often introduced through home-based intervention services such as early intervention and ABA (applied behavior analysis) programming (Jurgens, Anderson, & Moore, 2009). Jurgens and colleagues assessed the success of PECS with a 3-year-old boy with ASD, finding training with this intervention to be associated with generalized increases in verbal social-communicative behaviors, observed vocabulary, and mean length of utterance in various settings (2009). It is possible that participants using AAC interventions other than VOCA in the current study may use them in an augmentative (supplemental) sense rather than as an alternative (primary) means of communication depending on the goals of therapy pertaining to language acquisition in terms of pace and expected progress. This could potentially explain the lack of difference of total words rate between the VOCA and non-VOCA groups.

A number of limitations must be considered regarding the current study. First, the small sample size, which consisted of mostly white, male participants, calls into question the ability to generalize findings across settings and populations. Secondly, as one of the criteria for participation was a vocabulary of fewer than 20 different words said, signed or selected, previous researchers classified all children as nonverbal, making their time 1 data a quantitative score of zero. The original data analysis plan

involved a paired samples T-test, which would identify the change between time 1 and time 2 for the core sample with available data for both assessments, but had to be changed to an independent samples T-test upon further cleaning of the dataset. It is possible that differences in language abilities at time 1 still existed despite the nonverbal classification given by researchers determining participant qualification for entry into the study, which must also be considered when analyzing the current results. The six language assessments used to determine each participant's total words rate scores, the dependent variable in the current study, were originally developed to evaluate the expressive and receptive language of typically developing children. These underlying measures may not be sensitive enough to the language skills of children with developmental disabilities, the population composing the sample used in this research. Though the total words rate score accounted for a range of means of expression (words spoken, signed, or selected), the six language assessments may not have accurately measured the progress and abilities of participants being observed.

It should also be noted that an outcome variable clarifying participants' method(s) of communication would be useful. This would help researchers identify the associated benefits of specific AAC interventions. For instance, using PECS may increase an individual's selected and signed language, while VOCA may increase an individual's selected and verbal language. Findings of the current study still lend themselves to useful information regarding the effects of VOCA on language acquisition, but future studies should consider looking at a randomly selected sample with a wider quantitative range of expressive vocabulary linked to identifiable communicative means. Additionally, participants' IQ scores were not obtained by

previous researchers, which could potentially provide rationale for the progress of language acquisition and success of intervention methods in the current study, though it is important to note IQ scores are not always indicative of the presence of a disability or its severity.

Future researchers should also consider identifying the type and severity of a child's diagnosis during data collection so subsequent findings can be correlated with these factors, which are not measurable in the current study. Though the current study looked specifically at participants with an ASD diagnosis, the sample size and lack of data identifying the functioning level of each individual made results difficult to analyze in terms of a relational direction. Considering the broad spectrum of symptoms associated with ASD, the benefit of utilizing VOCA for each participant could drastically differ based on the severity of their social communication and interaction deficits. The current study also suggests the need for future research comparing the impact of aided and unaided communication systems on the language acquisition of specific populations, with a predetermined purpose of intervention methods as either augmentative (supplemental) or alternative (primary).

CONCLUSION

The findings of no significant difference between participants using VOCA and those using other forms of AAC indicate that AAC interventions should be chosen on an individual basis with consideration to the baseline skills associated with other developmental domains such as motor coordination and cognitive processes which

support recall memory. The findings of no significant difference between participants using VOCA with an ASD diagnosis and those using VOCA with other developmental disabilities also suggests an individualistic approach to linguistic therapy strategies with an emphasis on a strengths-based approach. There are a wide variety of AAC devices available to nonverbal individuals, making the decision of parents, teachers, and speech pathologists of which to use and implement a substantial task, one that needs the guidance of research based evidence. Future research should consider looking at a randomly selected sample with a wider quantitative range of expressive vocabulary, as well as obtaining the identification of the type and severity of a child's diagnosis to further clarify the evidence-based benefits of VOCA with specific populations.

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