Effects of a systematic AAC intervention using a Speech Generating Device on multi-step requesting and generic small talk for children with severe Autism Spectrum Disorder

Tiffany N. Chavers[a], Madison Morris[a], Ralf W. Schlosser[b,c], & Rajinder Koul[a]

[a]Department of Speech, Hearing, and Language Sciences, University of Texas at Austin

[b]Department of Communication Sciences and Disorders, Northeastern University

[c]Department of Otolaryngology and Communication Enhancement, Boston Children's Hospital

Author Note

We have no conflicts of interest to disclose.

Correspondence concerning this article can be addressed to Tiffany N. Chavers, Speech, Language, and Hearing Sciences, University of Texas at Austin, 2504A Whitis Ave. (A1100), Austin, TX, 78712. Email: tiffany.chavers@austin.utexas.edu

Abstract

Purpose: To determine the effects of augmentative and alternative communication (AAC) intervention using a speech-generating device (SGD) on acquisition, maintenance, and generalization of multi-step requesting and generic small talk in three children with severe autism spectrum disorder (ASD) between the ages of 7 and 13 years.

Method: A multiple baseline design across participants combined with a post-treatment multiple generalization probe design was used to assess acquisition, generalization, and maintenance of target communicative behaviors with the experimenter and the participants' familiar communication partners. Intervention comprised of systematic instruction in the use of an SGD using least-to-most prompting, constant-time delay, error correction, and reinforcement.

Results: Visual analysis established a strong functional relationship between the independent variable and the two dependent variables (i.e., requesting preferred activities, engaging in generic small talk) for all three participants. Effect size indicator analyses corroborated these findings, indicating strong effects for performing multi-step requesting and medium effects for engaging in generic small talk. All participants were able to generalize the acquired communicative behaviors to request new and untrained snacks and activities and engage in generic small talk with familiar communication partners who were not part of the training. Maintenance of acquired communicative behaviors was demonstrated three weeks post completion of intervention.

Conclusion: This study provides preliminary evidence that AAC intervention using an SGD and incorporating least-to-most prompting, constant time delay, error correction, and reinforcement is effective in terms of multi-step requesting and generic small talk behaviors in children with severe ASD.

Effects of a systematic AAC intervention using a Speech Generating Device on multi-step requesting and generic small talk for children with severe Autism Spectrum Disorder

According to the "Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition" (DSM-5), individuals diagnosed with autism spectrum disorder (ASD) have prevalent deficits in social communication and exhibit restrictive and repetitive behaviors, interests, or activities (American Psychiatric Association, 2013). The most salient deficit in individuals with ASD is social communication. Approximately 30-40% of individuals diagnosed with ASD fail to develop functional speech, and remain nonverbal or minimally verbal throughout their life span (Howlin et al., 2014; Pickles et al., 2014; Tager-Flusberg & Kasari, 2013). Minimally-verbal children with ASD are an underserved and under-researched part of the spectrum (Tager-Flusberg & Kasari, 2013). These children face severe deficits in social-communication skills, social interaction, daily living, and adaptive behavior skills (Park et al., 2012). Therefore, these deficits have significant impact on integral outcomes such as academic achievement, vocational accomplishment, and social relationships (Wodka et al., 2013). In order to facilitate communication, many individuals with ASD receive specific instruction in the use of augmentative and alternative communication (AAC) strategies, aids, and techniques. AAC intervention entails supplementing or replacing natural speech through either unaided (e.g., gestures, manual signs) and/or aided (e.g., speech-generating devices) methods (Koul et al., 2001). Research indicates that individuals with ASD can make substantial gains in functional communication skills using low-tech AAC systems (Ganz et al., 2012a; Hart & Banda, 2010; Preston & Carter, 2009) or high-tech AAC systems (Ganz et al., 2017; Morin et al., 2018; Schlosser & Koul, 2015; Sievers et al., 2018; Tincani et al., 2020).

For typically developing children, early stages of language development include producing single words to express daily needs and wants. As their language develops, typically developing children expand their vocabulary and begin combining words into complex utterances (Nigam et al., 2006). For instance, a social communication skill, such as requesting, expands as the child develops language to express more complex information. For a typically-developing child, an early form of requesting may include pointing and vocalizations, while more complex requests may include phrases and sentences to adequately communicate information (Nigam et al., 2006). Similarly, children with severe ASD may begin communicating with single graphic symbols to express their wants and needs, and later combine symbols to engage in relatively more complex socio-communicative and socio-relational interactions (Nigam, 2001). Limiting communication training to single symbols has been found to hinder the development of language skills and prevent effective communication (Achmadi et al., 2012). To date, most studies have examined the effectiveness of teaching requesting via a simple single-symbol selection on a page screen of dedicated speech-generating devices (SGDs) or mobile technologies such as tablets (e.g., iPad©[1], Microsoft Surface®[2]) with AAC-specific applications (Alzrayer et al., 2014; van der Meer & Rispoli, 2010). Further, systematic and scoping reviews have revealed a critical need for additional empirical studies to document the effectiveness of AAC strategies and techniques in facilitating production of social communicative functions such as initiating conversation, answering questions, and engaging in generic and specific small talk (e.g., Alzrayer et al., 2014; Ganz et al., 2017; Ganz et al., 2012b; Muharib & Alzrayer, 2018). Generic small talk refers to communicative acts that do not contain specific shared information and is used with a variety of different communication partners (e.g., "good story," "that is awesome"). In contrast, specific small talk may be used with familiar

communication partners (e.g., “good story about your birthday party,” “that movie was awesome”) to communicate shared information (Beukelman & Light, 2020). About half of the utterances of preschool children in home and school settings are classified as a generic small talk (Ball et al., 1999). Generic small talk facilitates social interactions and helps initiate and maintain conversation.

Few studies involving SGDs have addressed teaching individuals with ASD to locate and combine symbols to make requests, communicate greetings and farewells, and engage in generic small talk. Specifically, Waddington et al. (2014) taught three participants with ASD who ranged in age from 7 to 10 years to perform three-step sequences to request and produce a social communication response (i.e., “*thank you”*) using Proloquo2Go®[3] on an iPad. Intervention included systematic instruction involving least-to-most-prompting, time delay, error correction, and reinforcement. Results indicated that all participants acquired the skill to combine two symbols to make general requests (e.g., “*I want a toy.”)* and specific requests (e.g., “*I want the doll.”*) using an iPad. Participants’ production of social communication responses, however, was highly variable and required a greater number of training sessions than teaching of the “requesting.” The authors suggested that this finding may be related to the social communicative impairment associated with ASD or the insufficient motivation to engage in social communicative responses after receiving a preferred item. Another study investigated the effect of 5-s time delay and full physical prompt on answering personal questions in two individuals with ASD (Lorah et al., 2015). The participants were 8 and 12 years old, respectively. Both participants learned to select a single symbol to answer three different personal questions and took an average of four sessions to acquire the target behavior. The prompting procedure was found to be effective in facilitating skills to respond to a personal question.

Furthermore, Alzrayer et al. (2017) investigated the effects of systematic instruction involving least-to-most prompting, error correction, reinforcement, and time-delay on teaching multi-step requesting using Proloquo2Go to four children with ASD and other developmental disabilities. The participants ranged in age from 8 to 10 years. The results showed that all participants acquired the ability to navigate through three levels pages and combine symbols to request preferred snacks or activities. However, results of this study may have been confounded by the display of only one symbol on the main page and second page and the display of symbols in the same locations (i.e., position bias) on the third page during both intervention and generalization phases. Alzrayer et al. (2019) conducted another study examining the effects of systematic instruction involving least-to-most prompting, error correction, time delay, and reinforcement on multi-step social communication skills in three participants (age range = 7 to 10 years) with severe ASD. The intervention consisted of the participant requesting a preferred item, answering personal questions and saying, "*thank you*" using Proloquo2Go on an iPad. One participant was successful at using the iPad to perform multi-step requesting; the two other participants needed additional modifications to acquire multi-step requesting. These modifications weakened the overall experimental control and thus impacted the internal validity of the study.

In addition to the study by Alzrayer et al. (2019), other investigators have begun to study expansions of the requesting function itself (e.g., requesting actions instead of objects) and/or expansions to other communicative functions as well as with interventionists other than paid adult experimenters. For example, using a randomized group design study, Thiemann-Bourque et al. (2018) investigated the effects of an SGD-based intervention that incorporated a peer-mediated approach with 45 nonverbal or minimally-verbal preschoolers with ASD. Results

indicated that the participants were able to engage in social communicative behaviors such as initiating communication as well as responding to communication by using speech, an SGD, gestures, or vocalizations following intervention. In a follow-up study, Bourque and Goldstein (2019) investigated the effectiveness of a peer-mediated SGD intervention in six children (age range = 3.7 to 4.11 years) with moderate to severe ASD. They observed positive outcomes for all participants with respect to requesting objects from peers using speech, the SGD, and gestures. They also noted modest improvements in commenting and requests for action in several of their participants.

Kasari et al. (2014) found that a treatment package consisting of a blended developmental/behavioral intervention (Joint Attention Symbolic Play Engagement and Regulation + Enhanced Milieu Teaching) along with an SGD resulted in improvements in spontaneous communicative utterances (i.e., requests, comments, protests) in a group of 5-8 year old minimially-verbal children with ASD. It is important to realize, however, that the children included in this study began the intervention while already in the "word combination stage" of language development (Yoder et al., 2014).

Although the aforementioned studies demonstrated positive outcomes, several critical variables that potentially impact intervention outcomes need to be further investigated (Alzrayer et al. 2017, 2019; Bourque & Goldstein, 2019; Kasari et al., 2014; Lorah et al., 2015; Thiemann-Bourque et al., 2018; Waddington et al., 2014). For example, some of the studies summarized above did not include a symbol identification task prior to intervention (e.g., Alzrayer, 2017; Lorah et al., 2015; Thiemann-Bourque et al., 2018; Waddington et al., 2014). Consequently, it is unknown whether the participants were able to discriminate between symbols and had the conceptual knowledge of the symbol-referent relationship going into the study. Receptive

knowledge of the referent has been known to provide an easier path to symbol acquisition because the individual can map a new symbol onto a referent that is already known (Schlosser & Sigafoos, 2002). On the other hand, an individual who does not have receptive knowledge of the referent has to learn a new symbol and a new referent while also acquiring their relation.

Furthermore, none of the above studies explored the teaching of small talk to minimally-verbal children with ASD. Additionally, many of the above studies did not address generalization at all or did not examine generalization to other communication partners (e.g., Alzrayer et al., 2017, 2019; Lorah et al., 2015; Waddington et al. 2014). While Alzrayer et al. (2017) implemented a generalization phase with different preferred activities or storybooks, they did not include different communication partners. Therefore, it is unknown whether participants were able to generalize newly acquired communication skills to other communication partners.

Thus, the present study investigated the effectiveness of systematic instruction in facilitating multi-step requesting and social communication interactions between individuals with severe ASD and their communication partners. Systematic instruction involving least-to-most prompting, time delay, error correction, and reinforcement was implemented as the intervention because of the positive outcomes from previous research in teaching early communicative behaviors to children with ASD (e.g., Alzrayer et al., 2017, 2019; Flores et al., 2012; Waddington et al., 2014). Our procedures carefully separated teaching from testing (probing), and the participants performed multi-step requesting and small talk during the probes without adult prompts used during teaching. The social communication interaction behaviors targeted in this study included greetings, farewell statements, and generic small talk. Specifically, the following research questions were addressed. What is the effect of systematic instruction using an SGD on: (a) the acquisition and maintenance of multi-step requesting of

preferred activities with experimenters and familiar communication partners? (b) engaging in generic small talk behaviors with experimenters and familiar communication partners? (c) the generalization from trained to untrained objects and activities for requesting? (d) generalization of requesting and generic small talk behaviors from experimenters to familiar communication partners that were not part of the intervention?

Method

Participants

Five children between the ages of 7 and 13 years were initially screened for participation. Out of these, one participant did not meet the inclusion criteria, and a second participant began the study but withdrew shortly after enrollment. In total, three of the four participants who met inclusion criteria completed the study. The participants met the following inclusion criteria: (a) a diagnosis of severe ASD (based on the Childhood Autism Rating Scale – 2 [CARS-2], Schopler et al., 2010); (b) less than 10 functional words; (c) no physical or sensory impairments of such severity that they could interfere with operating an SGD (based on school records and symbol identification task); and (d) limited ($\leq$ 1 month) to no history of using an SGD for communication purposes. Participants who did not meet the above mentioned inclusion criteria were excluded from the study. All participants were diagnosed with ASD by either a developmental pediatrician or a school psychologist according to educational/clinical records. Each participant was administered the CARS-2 (Schopler et al., 2010), the Test of Nonverbal Intelligence (TONI-4; Brown et al., 2010), and the Receptive One Word Picture Vocabulary Test (ROWPT-4; Martin & Brownell, 2011). The study was approved by the Institutional Review Board. Consent was obtained from all parents. Table 1 provides detailed information about the participants' clinical and demographic characteristics.

Insert Table 1 about here

Joseph was a 9-year-old Caucasian male with a diagnosis of severe ASD and speech impairment. He received a CARS-2 score of 42 indicating severe ASD. His TONI-4 standard score was 95, placing him in the 37th percentile. His ROWPVT-4 standard score was 42, placing him in the 1st percentile. Parental report and CARS-2 ratings revealed that Joseph had no experience using aided AAC and communicated his wants and needs using gestures and unintelligible one-word utterances. Joseph demonstrated challenging behaviors such as pica (e.g., eating inedible items), self-injurious behavior (e.g., biting his wrists), and escapism (running away, covering ears) when agitated, tired, or frustrated. During the school week, Joseph attended school for half of the day and then participated in applied behavior analysis (ABA) intervention at home for the second half of the day. He received speech-language intervention twice a week to target speech intelligibility and expressive and receptive language functions.

Eleanor was a 9-year-old Caucasian female with a diagnosis of severe ASD based on a CARS-2 score of 47. Her TONI-4 standard score was 75 with a percentile rank of 5 and her ROWPVT-4 standard score was <55 with a percentile rank <1 percentile. Parents reported that Eleanor had not received any formal AAC intervention prior to the study. Parent report confirmed by experimenter observation revealed that Eleanor primarily communicated her wants and needs through unintelligible one to two-word utterances and idiosyncratic vocalizations. Eleanor presented with challenging behaviors such as self-injurious behavior and aggression towards others when she was unable to communicate her wants and needs. She received ABA therapy 5 days a week during school hours and speech-language intervention once a week to facilitate her oral communication.

Wade was a 7-year-old African American male with a diagnosis of severe ASD based on a CARS-2 score of 37. He received a standard score on the TONI-4 of 68 with a percentile rank of 2 and a ROWPVT-4 standard score of <55 with a percentile rank of <1. Teacher reported that about one month before the study, Wade started using the Proloquo2Go AAC app and was able to navigate between two screens to request snacks given verbal, gestural, and physical prompts. Data from the CARS-2 indicated that Wade's spoken communication was primarily echolalic and that he communicated his wants and needs through gestures, reaching for items, and nodding for "yes" or shaking his head to indicate "no." Wade attended a school that specialized in teaching children with ASD and other developmental disabilities. He received speech-language intervention twice a week to target expressive and receptive language functions. Wade did not receive ABA therapy.

Joanna was a 13-year-old, Caucasian female with a diagnosis of severe ASD based on a CARS-2 score of 48.5. Her TONI-4 standard score was 62, placing her in the <1st percentile. Joanna's ROWPVT-4 score was <55 placing her in the <1st percentile. Her speech was unintelligible. Joanna's family had tried AAC prior to the study but discontinued because of parental concern that AAC would inhibit their daughter's speech development. Joanna attended a school that specialized in teaching children with ASD and other developmental disabilities. After completing the screening tasks, Joanna was determined to be ineligible to participate in the study due to her inability to reliably select icons on a symbol identification task as a result of a fine-motor impairment.

Eric was a 7-year-old, Asian Indian male with a diagnosis of severe ASD based on a CARS-2 score of 43.5, confirming severe ASD. His TONI-4 standard score was 55, placing him in the <1st percentile. Eric's ROWPVT-4 score was <55 placing him in the <1st percentile. Eric

communicated by physically leading individuals to what he wanted to do, grabbing items in reach, and using idiosyncratic vocalizations. He had no prior experience with AAC. Eric exhibited challenging behaviors such as avoidance and escapism (i.e., crying and covering ears). After successfully completing screening tasks, Eric was dropped from the study because of his unavailability.

Settings

The study took place in each participant's home, school, or ABA clinic that they attended. Sessions with Joseph took place during a scheduled snack time in a dining area in his home that consisted of a table and four chairs. The dining area was closed off to limit distractions. Eleanor's sessions took place in a small material room at an ABA clinic. The material room consisted of bookshelves of therapy materials and a rug to sit on. Wade's sessions took place at a school that specialized in teaching children with ASD and other developmental disabilities. His sessions occurred in the cafeteria area of the school or the sensory room that was adjacent to the cafeteria. The cafeteria was an open space that consisted of a kitchen and multiple table and chairs. The sensory room contained a sensory swing, yoga balls, and padded floors. Each participant was exposed to experimental conditions for three times per week over a period of approximately three months. The duration of each session was 20 min.

Experimental Design

A multiple baseline design across participants was used in this study (Ledford & Gast, 2018). There were four phases: baseline, intervention, generalization, and maintenance. The baseline sessions were implemented by the experimenter and a familiar communication partner across all participants concurrently. The experimenter was a licensed speech-language pathologist enrolled in the doctoral program. A familiar communication partner was defined as

someone who interacted with the participant on a daily basis, such as parents, teachers, and other therapists. Joseph's familiar communication partner was his mother. Eleanor's familiar communication partner was her ABA therapist. Wade's familiar communication partner was his teacher. When the baseline data points were stable (i.e., no more than 5% variability on the dependent measures) across all participants, the intervention was implemented one-on-one between the experimenter and the first participant (i.e., Joseph). Once Joseph reached the acquisition criteria (80% or higher across three consecutive sessions for one of the dependent variables), the intervention was implemented with Eleanor. A similar procedure was followed with Wade. One week after all participants reached a criterion level (i.e., 80% across three consecutive sessions), the generalization phase was implemented.

A post-treatment multiple-generalization-probes design was used to assess generalization to untrained preferred items and across communication partners (Schlosser & Braun, 1994). Specifically, the familiar communication partners probed untreated preferred items across all participants. This method allowed us to repeatedly measure untreated items. Two weeks after the completion of the generalization phase, a single-post treatment maintenance probe (Barrios & Hartmann, 1988) was implemented with both the experimenter and the communication partner probing preferred stimuli from baseline, intervention, and generalization phases.

Materials

An Indi 7 Communication tablet with Snap + Core First ®4 (Tobii Dynavox, 2019) and Picture Communication Symbols®4 (PCS; Mayer-Johnson Company, 1994) served as materials. We chose the Indi 7 with Snap + Core First ®4 (Tobii Dynavox, 2019) dedicated SGD as it allows for a variety of input access techniques and is adaptable to particular motor, cognitive, and sensory perceptual needs and abilities of AAC users and allows for greater customization of

display compared to mobile technologies with AAC-specific applications. PCS symbols were used as they have been found to be more transparent and more easily learned across word classes than other static graphic symbols (e.g., Mirenda & Locke, 1989).

The SGD was configured into a three-level page to target production of requesting behavior for snacks and activities and a two-level page to target generic small talk behaviors. The first page consisted of the symbols for "I want," "small talk," "core words," and "quickfires". The "core words" or "quickfires" were placed as foils and therefore did not produce speech output and were not linked to an additional page. The selection of "I want" led to a second page consisting of four categories, "snacks," "chores," "activities," and "furniture." The selection of "snacks" and "activities" led to a page consisting of four preferred snacks and activities for each participant, respectively. The symbols for "chores" and "furniture" served as foils. Eleanor's symbols for baseline and intervention phase included snacks such as starbursts candies and red hots candies and activities such as puzzles and drawing. For the generalization phase, Eleanor's symbols included activities such as coloring and books and snacks such as pickles and goldfish. Wade's symbols for the baseline and intervention phase included a number of different sensory and play activities (e.g., swinging, jumping) as well as desired snack choices such as cookies and bananas. For the generalization phase, Wade's symbols included snacks such as fruit snacks and chips and activities such as trains and rolling a yoga ball. For the baseline and intervention phase, Joseph's symbols included desired activities such as playing on the trampoline and puzzles and desired snacks such as snap peas and watermelon.

The selection of "small talk" led to a second page consisting of the PCS for following messages: "Hi, how are you?," "See you later," "I like it," and "I don't like it." All four of these symbols resulted in speech output. The location of symbols across screens was randomized at the

beginning of each session to control for position effects. A text label (gloss) was added beneath each symbol. See figure 1 for an example of the pages used to target requesting activities and snacks and engaging in generic small talk for Joseph.

Insert Figure 1 about here

Procedures

All participants were administered a preference task, a symbol identification task, and several standardized tests to ensure that they met the inclusion criteria and to identify preferred stimuli for the intervention. Additionally, familiar communication partners completed a brief training (described below) before administering generalization and maintenance probes.

Standardized Assessments

Participants were administered three formal assessments to determine their non-verbal intelligence, receptive vocabulary, and ASD severity. First, the experimenter administered the TONI-4 (Brown et al., 2010) to assess each participant's non-verbal intelligence. Participants were then given the ROWPVT-4 (Martin & Brownell, 2011) to assess their receptive vocabulary. Lastly, the participants' parents or teachers completed the CARS-2 (Schopler et al., 2010) to determine severity of autism. Prior to the implementation of the CARS-2, the experimenter discussed each of the 15 items being rated with the participant's parents or teachers. Specifically, after a rating item was explained, the participants' parents or teachers were given the opportunity to ask questions. After each item was rated, the experimenter probed each rating for further information. Additionally, during the preference assessment and symbol identification task, the experimenter compared her observations to the participants' parents or teachers' ratings on the CARS-2. On the CARS-2 (Schopler et al., 2010), total scores of 15 to 29 are associated with

minimal-to-no symptoms of ASD. Total scores of 30 to 36.5 are associated with mild-to-moderate symptoms and scores above 37 reflect severe symptoms.

Preference Assessment

The preference assessment was conducted in two steps. First, the experimenter (i.e., first author) completed an indirect preference assessment. The indirect preference assessment consisted of sending an email to the participant's teacher and parents requesting a list of ten preferred snacks and activities in order of most preferred to least preferred. The experimenter provided examples of snacks and activities that could be included in the list, such as manipulatives and sensory toys, hands-on activities, and music. Each participant's teacher or parent responded and provided a list of preferred toys and snacks to the experimenter. The participant's top five preferred activities were used as stimuli for further preference testing if they met the following criteria: (a) indoor activity, (b) restricted access, and (c) could be used in the context of the intervention session setting.

A free-operant procedure (Roane et al., 1998) was used to document each participant's most preferred activities during free time. A total of three sessions were conducted over a three-day period with each participant. Each session lasted approximately 10 min. At the beginning of each session, the experimenter placed five preferred activities selected from the indirect preference assessment except snacks on a table or a carpeted play area. Participants were then instructed to play with any activity that they liked. The experimenter did not engage with the participants during preference assessment trials. The experimenter recorded the amount of time the participant engaged in each activity. The five activities with the longest duration of engagement were considered as preferred activities and the five activities with the shortest duration were considered non-preferred or neutral activities.

Symbol Identification Task

After the participant completed a preference assessment, a symbol identification task was administered with each participant's preferred and non-preferred activities. The symbol identification task was not implemented for generic small talk symbols because such communicative behaviors do not lend themselves to preference assessment. The participant's top five preferred items and five non-preferred or neutral items were depicted in the form of photographs or PCS (Mayer-Johnson Company, 1994). Photographs were used with one participant because there were no PCS available that represented all preferred items for that participant. Each trial consisted of a target symbol and three randomly selected foils. The participants were asked to point to the target symbol in response to experimenter's spoken instructions (e.g., "which one is a puzzle?"). If the participant selected the correct symbol, the experimenter stated, "Great job!" and reemphasized that the participant had selected the target symbol. If the participant selected the incorrect symbol, the experimenter said, "Nice try" and showed the participant the correct symbol. The participants were required to identify all target symbols with 100% accuracy before proceeding with intervention.

Familiar Communication Partner Training

Familiar communication partners (FCPs) received instructions from the investigator on how to implement the baseline, generalization, and maintenance probes. The FCP training took place either at the participants' home, school, or ABA clinic they attended. The duration of FCP training lasted between 20-30 minutes. For baseline, generalization, and maintenance probes, partners were instructed to initially deliver a probe targeting greeting statements (e.g., "hi", "hello") and wait 15 s without providing any cues. If the participant did respond to the partner's probe, the partner was instructed to respond to the participant (e.g., "I am doing great;" "I am

having a good day"). If the participant did not respond to the partner's probe, the partner was instructed to initiate a requesting probe. To administer a requesting probe, the partner was instructed to ask the participant "what would you like to do" and wait up to 30 s for a response. No cues were provided. For baseline probes, the partner was instructed to provide the desired item to the participant for 30 s irrespective of whether the participant responded correctly or incorrectly to the probe. For generalization probes, if the participant responded correctly to the requesting probe, the partner was instructed to provide the desired item to the participant for 30 s. However, if the participant did not respond correctly to the requesting probe, the FCP was instructed to initiate a generic small talk probe. Following the requesting probe, the partner was instructed to probe a generic small talk response "Do you like [item/activity]?" and wait up to 15 s for the participant to respond. No cues were provided. If the participant did not respond to the probe, the partner was instructed to initiate another requesting probe. If the participant did respond to the generic small talk probe, the partner was instructed to respond to the participant (e.g., "I am glad you like [item/activity]"; "That does look like fun") and to initiate another requesting probe. After delivering four requesting probes and two generic small talk probes, the session ended with partners administering a farewell statement probe (e.g., "bye", "see you later") and waiting 15 s for the participant to respond without providing cues. The partner was instructed to end the session irrespective of whether the participant responded correctly or incorrectly to the probe. Prior to each baseline, generalization, and maintanence session, the investigator reviewed the guidelines for administering probes. Before administering probes to the participant, the partner had an opportunity to discuss the procedures and ask questions and practice probe administration (i.e., role play) with the experimenter.

Baseline

During baseline, the experimenter and the FCP placed two preferred and two non-preferred snacks or activities on a table within view but out of reach. The participant was given the SGD with an open display screen of the home page consisting of icons representing "I want," "small talk," "core words," and "quickfires." The experimenter started the session by greeting the participant and asking, "how are you doing?" If the participant did not respond within 15 s, the experimenter or FCP would ask the participant "what activity would you like to do?" while pointing to the activities on the table. If the participant did not request an item independently using the SGD within 30 s, the experimenter or partner handed the participant one of the preferred items and said, "Here you go." The participants were given 30 s to engage in an activity or consume a snack. After the participants enjoyed the item or activity for 30 s, the experimenter or FCP asked, "Do you like [item/activity]?"and waited 15 s for the participant to respond using the SGD. After four probes targeting requesting, one probe targeting greeting statements and two generic small talk probes were administered, the experimenter ended the session by saying, "We are all done today. See you later." Before returning to their classroom or home activities, the participant was given 15 s to provide a farewell statement using the SGD.

Intervention

The intervention phase was identical to the baseline phase, except only the experimenter was present with the participant, and implemented systematic instruction (i.e., least-to-most prompting, constant-time delay, error correction, reinforcements) and probed the responses. For example, if the participant did not request an activity or item within 30 s, the experimenter would begin systematic instruction. Systematic instruction began with the experimenter providing the participant with a verbal cue followed by a constant-time delay of 3 s. If the participant did not respond to the constant-time delay within 3 s, then the experimenter provided both verbal and

gestural prompts. Lastly, if the participant did not respond within 3 s of providing the verbal or gestural prompt, the experimenter physically guided the participant's hand to activate targeted icons. The experimenter immediately used an error-correction procedure if the participant activated the incorrect icon. This consisted of physically guiding the participant's hand and providing verbal prompts to activate correct icons.

Treatment Probes

Treatment probes were utilized to measure the participant's acquisition of the targeted communicative behaviors (e.g., requesting preferred activities and snacks, engaging in generic small talk). Each session was comprised of four treatment probes targeting multi-step requesting and four treatment probes targeting generic small talk. Probes for the latter included a greeting and farewell statement, and two generic small talk comments (i.e., "I like it;" "I don't like it."). The first treatment probe consisted of the experimenter greeting the participant (e.g., "hi;" "hello") and waiting 15 s for the participant to respond without giving any cues. Next, the experimenter administered a treatment probe for requesting (e.g., "what would you like to do") and then waited 30 s for a response without providing any cues. If the participant responded to the treatment probe independently and within 30 s, the experimenter handed the desired item to the participant to enjoy for 30 s. If the participant did not respond, the experimenter would not provide the desired item. The duration of 30 s was selected as a time delay for multi-step requesting responses due to the navigation demands of the experimental task (i.e., three pages). After completing a requesting treatment probe, a generic small talk treatment probe was administered. A generic small talk treatment probe consisted of the experimenter asking the participant "Do you like [item/activity]?" and waiting 15 s for the participant to respond without giving any cues. Requesting and generic small talk treatment probes were administered randomly

throughout the session. Each intervention session ended with the experimenter administering a farewell statement probe (e.g., “bye;” “see you later”) and waiting 15 s for the participant to respond without giving any cues. The duration of 15 s was selected as a time delay for generic small talk responses due to the reduced navigation demands (i.e., two pages) and contextual manner of the experimental task. After the participant reached a criterion of 80% accuracy across three consecutive intervention sessions, the generalization phase was implemented.

Generalization

The generalization phase was implemented one week following the last intervention session. The procedure for this phase was identical to the procedure in the baseline phase, except that the FCP (instead of the experimenter) probed the dependent variables with new and untrained preferred activities or snacks.

Maintenance

A single maintenance probe was implemented two weeks after the generalization phase. The maintenance probe consisted of four opportunities to target multi-step requesting and four opportunities to engage in generic small talk. The 20-min procedure for this phase was identical to the procedure in the baseline phase, except that the FCP and the experimenter probed the dependent variables using preferred activities or snacks from the baseline, intervention and generalization phases.

Insert Table 2 about here

Dependent Measures and Definitions

The dependent variables were multi-step requesting and engaging in generic small talk. The dependent measures were the percentage of correct responses for symbol combination when requesting a preferred activity or snack or engaging in generic small talk. When requesting a

preferred activity or snack, the operational definition for a correct response was the participant independently combining symbols by selecting (a) the folder labeled “I want” on the first page, (b) the folder labeled “snacks” or “activities” on the second page, (c) the specific symbol that represents the preferred snack or activity on the third page, and (d) the message bar to activate speech output within 30 s of the experimenter’s or FCP’s probe. The operational definition for producing generic small talk was independently selecting (a) the “small talk” folder on the first page, (b) the socially appropriate symbol on the second page in response to the communication partner’s utterance (e.g., “Hi, how are you?”, “I like it”, “I don’t like it”, “see you later”) and (c) the message bar to activate speech output within 15 s of the experimenter’s or FCP’s probe. Each session consisted of four requesting and four generic small talk probes. If a participant responded correctly for 2 of the 4 requesting probes, their percent correct response was 50%.

Responses were counted as correct if the participant used his or her finger to touch the symbol that corresponds to the selected item with enough pressure followed by selecting the message bar to activate speech output. Incorrect responses were scored as zero and included: (a) pressing at least one incorrect icon within the entirety of the sequence, (b) selecting icons multiple times, resulting in repetitive speech output, (c) selecting the home screen key to exit out of the Snap + Core application, and/or (d) requiring prompts to select correct icons.

Inter-observer Agreement and Treatment Integrity

The purpose of the study and the operational definition of the dependent variables were explained to the independent observer, who was a graduate student in speech-language pathology. Four videos from the baseline phase and four videos from the intervention phase were randomly selected for training purposes. Training continued until there was 100% agreement between the experimenter and the observer. After training was completed, the observer collected

real time data using paper-and-pencil for 36.84% of baseline sessions, 30% of intervention sessions, and 44.04% of generalization sessions. Interobserver agreement (IOA) was calculated by dividing the number of agreements by the number of agreements plus disagreements multiplied by 100. IOA was 100% accuracy across all phases and communication partners.

Three separate procedural/treatment checklists – one for baseline procedures, one for intervention procedures, and one for generalization procedures – were developed (Schlosser, 2002). For baseline and generalization probes, key procedural steps included the following: (a) symbols on SGD were randomized to prevent position bias; (b) four multi-requesting probes and four generic small talk probes were given; and (c) investigator and/or FCP did not provide prompts. For intervention, key procedural steps included the following: (a) investigator waited 30 s before providing systematic instruction to teach multi-step requesting; (b) investigator waited 15 s before providing systematic instruction to teach generic small talk behaviors; (c) investigator provided least-to-most prompting (for complete checklists, see Supplementary files). One video from the baseline phase and one video from the intervention phase were randomly selected for training purposes. The training continued until the observer reached 100% accuracy in collecting procedural and treatment integrity data. After the training, procedural and treatment integrity data were taken in real time during 30% of sessions during baseline, intervention, and generalization, respectively. Procedural/treatment integrity was calculated by dividing the number of correctly performed steps by the total number of steps multiplied by 100. Treatment integrity was 100% across all phases and communication partners.

Data Collection and Analysis

Data were analyzed and interpreted within and across phases for all participants for each dependent variable using level (i.e., the data points around the vertical axis), trend (i.e., the

direction of the overall data points), and immediacy (i.e., the latency in change of level, trend, and variability after conditional change; Barton, et al., 2018). To supplement visual analysis, Non-overlap of All Pairs (NAP) with a 95% confidence interval (Parker & Vannest, 2009) was calculated for multi-step requesting and generic small talk behaviors for each participant. NAP was used because of its strengths related to accuracy as well as its external validation relative to both R^2 and visual analysis judgments (Parker & Vannest, 2009).

Results

The results across three participants for the two dependent variables are presented below, beginning with multi-step requesting followed by generic small talk behaviors. Within each dependent variable, visual analyses results are reported prior to the results of the NAP effect size indicator.

Multi-step Requesting

Data for multi-step requesting are displayed in Figure 2. Visual analysis indicated that the data for Joseph, Eleanor, and Wade demonstrated functional control between the independent variable (systematic instruction and Snap + Core Plus application) and the dependent variable (percentage of correct responses for multi-step requesting). The combined NAP across all participants was 1.00 (strong effect) with 95% CI (.7733, 1.00). These results were replicated for generalization, and maintenance phases as well.

Insert Figure 2 about here

Joseph

Joseph did not navigate across three pages to request preferred snacks and activities during the baseline phase. Therefore, no level, trend, or variability was observed during the baseline phase. During the intervention phase, Joseph met the acquisition criterion after three

sessions of training during which he averaged 91.67% (range: 75-100%) for multi-step requesting. The intervention data clearly indicated a change in level compared to baseline data, a change in trend to a positive trend, and low variability. Furthermore, the data showed no overlap between baseline and the intervention phases. Joseph's NAP for multi-step requesting was 1.00 (strong effect) with 95% CI (.4605, 1). During the generalization phase, Joseph consistently navigated through three pages to request untrained preferred snacks and activities from the communication partner not involved in training with 100% accuracy across probes. Maintenance data (i.e., 100% accuracy) suggest that Joseph sustained the ability to use an SGD to perform multi-step requesting three weeks after the last intervention session.

Eleanor

Eleanor did not use an SGD to request preferred snacks and activities during the baseline phase. Hence, there was no level, trend, or variability. Eleanor showed rapid progress when intervention was implemented. She met the acquisition criterion after three sessions of training, during which she averaged 100% accuracy for multi-step requesting. A change in level, positive trend, and no variability was shown in Eleanor's intervention data. Her NAP for multi-step requesting was 1.00 (strong effect with a 95% CI [.538, 1.00]). Eleanor continued to request preferred snacks and activities with 100% accuracy across generalization probes. As indicated by maintenance probes, Eleanor also sustained the ability to use an SGD to perform multi-step requesting three weeks after the last intervention session.

Wade

As shown in the third panel of Figure 2, during baseline phase, Wade did not use the SGD to request preferred activities and snacks. Therefore, there was no level, trend, or variability. After the intervention was implemented, Wade met acquisition criterion after three

sessions, during which he averaged 83.33% accuracy for multi-step requesting (range: 50-100%). The intervention phase data indicated a change in level, change in trend toward a positive trend, and little variability. The data showed no overlap between the baseline and intervention phases. His NAP for multi-step requesting was 1.00 (strong effect) with a 95% CI (.6733, 1.00). During generalization probes, Wade's performance in multi-step requesting was consistent at 100% accuracy. The maintenance probe with 100% accuracy suggests that Wade maintained multi-step requesting three weeks following his last intervention session.

In summary, functional control between the independent variable (systematic instruction and Snap + Core Plus application) and the dependent variable (percentage of correct responses for multi-step requesting) was demonstrated across all participants.

Engaging in Generic Small Talk

Baseline and intervention data indicate that results on generalization and maintenance across three participants were favorable as well (see Figure 3). The combined NAP across all participants was .8333 (medium effect) with 95% CI (.6066, 1.00).

Insert Figure 3 about here

Joseph

During baseline, Joseph did not engage in greetings, generic small talk, and farewell statements with the experimenter or FCPs using an SGD. That is, baseline data showed no level, trend, or variability. During intervention, despite a delayed onset of change he met the acquisition criterion after eight sessions of training during which he averaged 83.33% accuracy (range 0-100%). The data showed a steady change in level compared to baseline, moderate variability, and a positive trend. His NAP for engaging in generic small talk was .8182 (medium effect) with a 95% CI (.2787, 1.00). During the generalization phase, Joseph's performance

ranged between 75-100% accuracy. Three weeks following Joseph's final intervention session, he maintained the ability to engage in generic small talk with 100% accuracy.

Eleanor

Eleanor did not engage in generic small talk with the experimenter or FCP using an SGD during the baseline phase. Therefore, the baseline data showed no level, trend, or variability. Eleanor met acquisition criteria after 6 sessions of training, during which she averaged 91.67% accuracy (range: 0-100%). After a somewhat delayed onset of change, the intervention data showed a change in level and upward positive trend, and little variability compared to the baseline data. Her NAP for engaging in generic small talk was .8571 (medium effect) with a 95% CI (.3952, 1.00). During the generalization phase, Eleanor consistently engaged in generic small talk with 100% accuracy. Three weeks following Eleanor's final intervention session, she maintained the ability to engage in generic small talk with 100% accuracy.

Wade

During the baseline phase, Wade did not use the SGD to engage in generic small talk with the experimenter or FCP. Hence, there was no level, trend, or variability during this phase. During the intervention phase, Wade met acquisition criteria after 11 sessions of training, during which he averaged 83.33% accuracy (range 0-100%) for engaging in generic small talk. After a somewhat delayed onset of change, the data indicated a change in level compared to the baseline, positive trend, and moderate variability. His NAP for engaging in generic small talk was .8333 (medium effect) with a 95% CI (.5067, 1.00). Wade independently engaged in generic small talk across all of the generalization and maintenance probes with 100% accuracy. The maintenance probe indicated that Wade maintained his ability to engage in generic small talk three weeks following his last intervention session.

In summary, after a delayed onset, the data for all three participants demonstrated functional control between the independent variable (systematic instruction and Snap + Core Plus application) and the dependent variable (percentage of correct responses for engaging in generic small talk).

Discussion

This study investigated the effectiveness of systematic AAC instruction (i.e., constant time delay, least-to-most prompting, and differential reinforcement) on facilitating multi-step requesting and generic small talk in children with ASD. The results indicated that all three participants acquired the ability to use an SGD to make multi-step requests for preferred snacks or activities and engage in generic small talk with the experimenter. Additionally, all participants were able to generalize the acquired communicative behaviors to request untrained preferred snacks and activities and engage in generic small talk with familiar communication partners who were not part of the intervention. The participants also seemed to maintain the acquired skills to make requests and engage in generic small talk two weeks after the last generalization session and three weeks after the last intervention session. Based on visual analyses conducted, the data for all three participants demonstrated strong functional control between the independent variable (e.g., systematic instruction) and the two dependent variables (e.g., requesting preferred activities, engaging in generic small talk). The results are consistent with previous studies indicating that children with severe ASD can perform multi-step requesting and engage in social interactions (Agius & Vance, 2016; Alzrayer et al., 2017, 2019; King et al., 2014; Lorah et al., 2015; Waddington et al., 2014). The somewhat delayed onset of change with small talk relative to requesting is consistent with previous findings that requesting is an easier-to-teach function

because it allows participants to exert immediate control over their environment (Schlosser et al., 2020; Sigafoos, 2003).

There is currently no consensus in the field how much delay is acceptable without impeding functional control (Lieberman et al., 2010). The immediacy of the effect is generally referred to as a level change between the last three data points of baseline and the first three data points in the intervention phase (Kratochwill et al., 2013). Lieberman et al. (2010) proposed three considerations that impact the functional relation between an IV and a DV when there is a delayed onset: (a) the steepness of the slope change; (b) the consistency of the delay; and (c) the expectancy of the delayed onset. In terms of steepness of the slope change, the slope change for both Joseph and Eleanor was indeed very steep and consistently so, whereas for Wade the change was initially somewhat variable before turning into a steep change as well. In terms of the consistency of the delay, the onset of change occurred after 1, 2, and 3 intervention sessions for Eleanor, Joseph, and Wade, respectively. This relative precise (within 1 session of each other) replication across participants of the latency between treatment phase onset and the beginning of change demonstrates a lawfulness that, according to Lieberman et al. (2013) and Parsonson and Baer (1992), is generally not explainable through maturation or other environmental influences. Finally, there are contextual variables such as relative difficulty in acquiring various communicative functions that provide support for the notion that instrumental functions such as requesting are more readily acquired in this population than more social-communicative functions such as commenting and small talk skills (Schlosser et al., 2020), and as such a delay was expected. Taken together, the functional control between intervention and engaging in small talk can be considered established despite the delay onset of change.

The efficacy of systematic instruction to teach multi-step requesting and conduct small talk is further bolstered by the results of the NAP analyses for all participants. All participants demonstrated effects that were 1.00 (strong effect) for performing multi-step requesting and between .8182 and .8571 (medium effect) for engaging in generic small talk. Because NAP has a strong relationship with both R^2 (Rho = .93) and visual analyst judgments (Rho = .84; Parker & Vannest, 2009), this potentially enhances the confidence in the validity of the results from this study. Our data replicate results from previous research that used NAP as an effect size indicator. For example, a study conducted by Alzrayer et al. (2019) demonstrated effect sizes between .90 and .97 (medium to strong effect) for multi-step requesting and between .81 and 1.00 (medium to strong effect) for multi-step "thank you" communication response.

Additionally, few studies have documented the effectiveness of AAC strategies and techniques in facilitating production of social communicative functions such as initiating conversation, answering questions, and commenting (Alzrayer et al., 2014; Bourque & Goldstein, 2019; Ganz et al., 2012b; Ganz et al., 2017; Muharib & Alzrayer, 2017; Thiemann-Bourque et al., 2018). The results of the current study address this critical need by providing preliminary evidence for an intervention strategy for teaching social communicative behaviors to children with severe ASD who require AAC strategies and techniques for communicative purposes. Notably, this study indicates that individuals with severe ASD are able to utilize AAC systems to acquire not only requesting behaviors, but also engage in more complex communicative behaviors, such as greeting and farewell statements and generic small talk. However, it must be noted that the participants in this study ranged in age from 7 to 9 years and were still using nonsymbolic modes of communication (e.g., idiosyncratic vocalization and gestures, reaching for items, etc.). The transition from pre-symbolic to symbol modes of

communicative behaviors is critical to allow for the expression of a wide range of communicative behaviors and typical children make this transition by about 10-14 months of age (Bloom, 2000). The lack of symbolic communication in our participants at 7-9 years old at the onset of this study reinforces previous urgent calls for early intervention research with this population as it pertains to language and communication (Brignell et al., 2018; Chenausky, 2017; Koegel et al., 2020; Tager-Flusberg & Kasari, 2013). Despite being prescribed AAC late in development, each participant demonstrated the ability to make multi-step requests and engage in generic small talk.

Past studies that targeted social communicative behaviors in children with ASD utilized a single symbol to communicate a "thank-you" response (e.g., Alzrayer et al., 2019; Waddington et al., 2014). The current study is an improvement over past work because we displayed four symbols (i.e., one target symbol and three foils) on a page thus requiring participants to discriminate and demonstrate their understanding of the symbol-referent relationship. Additionally, three social communicative behaviors were targeted (e.g., greeting and farewell statements and generic small talk) compared to one social communicative behavior being targeted in previous studies (e.g., thank-you response; Alzrayer et al., 2019; Waddington et al., 2014). In summary, the data clearly indicate that children with severe ASD can select the correct socially appropriate symbol from an array of symbols.

The results of this study provide strong support for evidence-based instructional strategies (i.e., prompting, error correction, and reinforcement) that were employed to teach target behaviors to participants in this study. Other studies using the same instructional strategies also reported positive outcomes (Achmadi et al., 2012, 2014; Alzrayer et al., 2017, 2019; Flores et al., 2012; Waddington et al., 2014). In addition to the use of evidence-based instructional

strategies, the rapid acquisition of requesting behavior may have been enabled by the participants' pre-existing understanding of symbol-referent relationships as demonstrated by a symbol identification task. Prior studies that utilized symbol identification tasks also reported strong treatment effects (Alzrayer et al., 2019; Lorah, 2016; Lorah et al., 2014). Furthermore, the use of transparent symbols such as photographs and line drawings may have also facilitated acquisition of multi-step requesting skills in relatively fewer sessions. Iconicity has a facilitative effect on symbol identification and learning within the context of pointing-based requesting (Schlosser & Sigafoos, 2002). Thus, the results of this study support the importance of symbol identification and iconicity in facilitating requesting skills in children with ASD.

Furthermore, page configuration and different types of reinforcement for the two dependent variables (conducting small talk and requesting) may have influenced the number of intervention sessions it took to acquire the target behaviors. For instance, when engaging in generic small talk, the participants navigated through two pages to select a socially appropriate symbol. After selecting the socially appropriate symbol, participants received natural social reinforcement (i.e., communication partner respond appropriately to the participant). On the other hand, when requesting preferred snacks and activities, participants navigated through three pages and received natural tangible reinforcement. Participants may have been more motivated to receive tangible reinforcement, thus acquiring the ability to request preferred snacks and activities relatively quickly compared to the ability to engage in generic small talk. These findings are consistent with prior studies in which the participants acquired target behaviors that resulted in access to a preferred item more quickly than social-oriented communicative skills (e.g., Alzrayer et al., 2019; Kagohara, et al., 2010; Schlosser et al, 2020).

However, irrespective of the absence of tangible reinforcement, all participants acquired the ability to engage in generic small talk in an average of 8.33 sessions indicating the effectiveness of overall intervention and ability of individuals with severe ASD to acquire communicative behaviors beyond requesting. These results suggest that natural social reinforcers (e.g., participating in an effective social communicative exchange) may be motivating enough for individuals with severe ASD to acquire, generalize and maintain a learned communicative behavior.

Finally, generalization data for all participants indicated that they were successful in requesting untrained preferred activities, stating greetings and farewells, and engaging in generic small talk using an SGD with FCPs that were not part of training. A meta-analysis has shown that generalization across more than one dimension is more difficult to achieve compared to generalization across just one dimension (Schlosser & Lee, 2000). The generalization effectiveness across two dimensions in this study (i.e., untrained preferred objects and activities; untrained communication partners) may be attributed to the implementation of preferred activities as stimuli, the training of FCPs to conduct probes, and familiarity of participants with the communication partners in the generalization phase. Future research should consider investigating acquisition of small talk communicative behavior with peers with ASD and unfamiliar communication partners.

Clinical Implications

Outcomes from this study suggest that practioners should consider AAC intervention using SGDs for children with ASD who are beginning communicators and present with little to no functional speech. Three participants with severe ASD in this study were able to generalize the acquired communicative behaviors across familiar communication partners and untrained

preferred items and activities. However, to achieve such outcomes, it is critical that practioners conduct a symbol identification task to ensure that their clients have the functional understanding of the referents and are able to discriminate between symbols. Additionally, it is important to provide differential reinforcement by reinforcing only the newly acquired desired symbolic communicative behavior and ignoring pre-symbolic behavior (Sigafoos et al., 2003). It is also essential that the messages on SGDs are organized in a way that is meaningful to the client and reduces the overall cognitive load for the client. The most successful outcomes are obtained when client's strengths/capabilities are matched to SGD features (Beukelman & Light, 2020).

Limitations

The results of this study should be considered in light of the following limitations. Although, we used a post-treatment generalization probes method to assess generalization for untreated preferred activities, it is important to indicate that the lack of baseline data for preferred activities probed in the generalization phase resulted in preponderant evidence but not conclusive evidence for this generalization dimension. Thus, we are unable to indicate with a high degree of certainty that intervention was the sole factor that caused generalization to non-trained preferred activities. Second, one participant, Wade, had some exposure to AAC prior to the beginning of the study. Thus, it is possible that this exposure to AAC may have had some role in his acquisition of target behaviors. Third, given that our participants were beginning communicators and their communicative behaviors were pre-symbolic, our initial focus was on teaching four generic small talk statements. The small talk intervention was integrated with the multi-step requesting intervention. However, more complex social communicative behavior entails production and comprehension of social communicative acts that go way beyond simple generic small talk. This limits the strengths of the study with respect to social communicative

behaviors. Future research should continue to focus on the acquisition, generalization, and maintenance of advanced socio-relational and socio-communicative behaviors, such as initiating, maintaining, and terminating conversations, commenting, and behaviors that strengthen socio-relational aspects of communication for children with ASD who use AAC strategies. Finally, only three children participated in the study and maintenance only included a single probe, precluding more definitve conclusions regarding the maintenance of the acquired skills. Thus, it is suggested that this work be systematically replicated with a larger cohort of children with ASD and multiple maintenance probes to further investigate efficacy of AAC intervention using SGD on social communicative behaviors.

Conclusion

The outcomes of this study suggest that SGD-based systematic instruction (i.e., constant time delay, least-to-most prompting, and differential reinforcement) leads to gains in multi-step requesting and responding to greetings/farewells and simple questions in three children with severe ASD.

Endnotes:

[1]Apple iPad© are registered trademarks of the Apple Corporation, Cupertino, California, www.apple.com

[2]Microsoft surface® is a product of Microsoft Corporation of Redmond, WA., https://www.microsoft.com/en-us/

[3]Proloquo2Go® is a registered trademark of AssistiveWare B.V., Amsterdam, The Netherlands, www.assistiveware.com

[4]The Dynavox™ is a product of the DynaVox Mayer-Johnson Company of Pittsburgh, PA., https://us.tobiidynavox.com

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Table and Figure Captions

Table 1. Clinical and demographic characteristics of the participants.

Figure 1. Screenshots of steps followed by Joseph to request a preferred activity and snack and engage in generic small talk.

Figure 2. The percentage of correct responses for requesting preferred activities and snacks.

Figure 3. The percentage of correct responses for engaging in generic small talk.

Figure 1

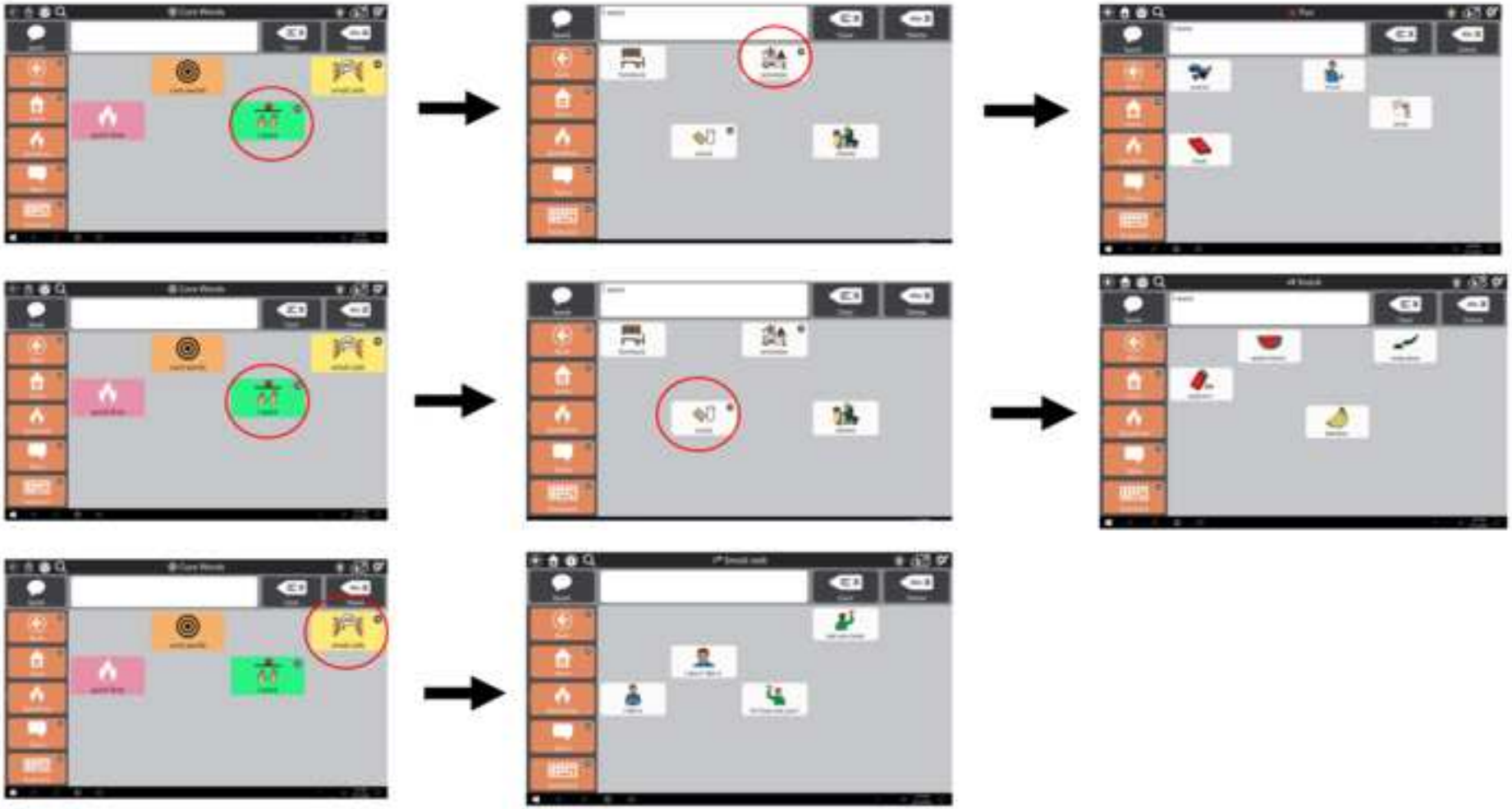

Figure 2

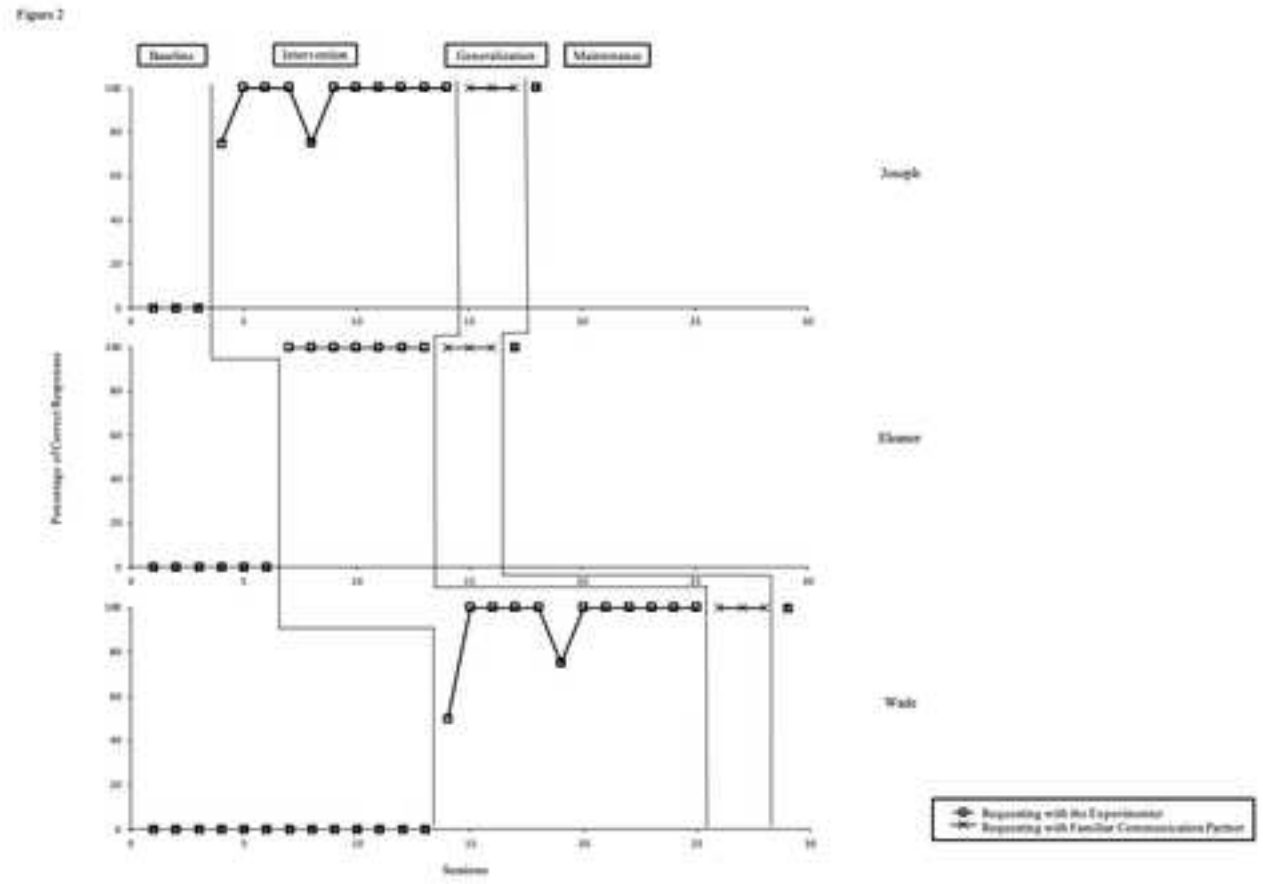
Baseline
Intervention
Generalization
Maintenance
Jungle
Eleanor
Wade
Requesting with the Experimenter
Requesting with Familiar Communication Partner

Figure 3

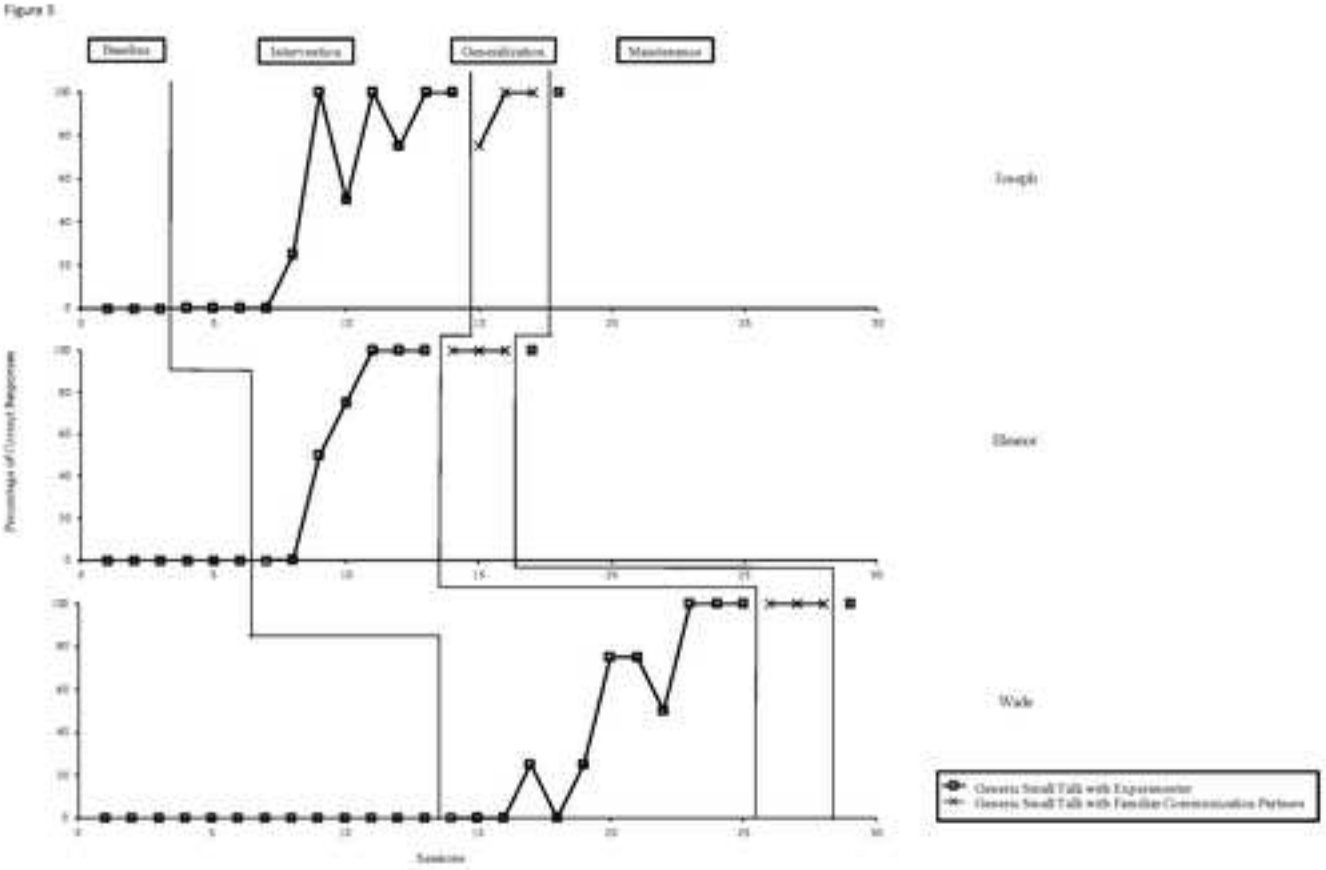
Baseline
Intervention
Generalization
Maintenance
Joseph
Eleanor
Wade
Percentage of Correct Responses
Sessions
Generic Small Talk with Experimenter
Generic Small Talk with Familiar Communication Partners

Table 1

Participants	Age	Gender	CARS -2			TONI-4		ROWPVT-4		Familiar Communication Partner
			Standard Score	Percentile	Severity	Standard Score	Percentile	Standard Score	Percentile Rank	
Joseph	9;1	Male	42	69	Severe	95	37	<55	<1	Mother
Eleanor	9;7	Female	47	86	Severe	75	5	<55	<1	ABA therapist
Wade	7;1	Male	37	42	Severe	68	2	<55	<1	Teacher
Joanna	13;6	Female	48.5	92	Severe	62	<1	<55	<1	N/A
Eric	7;5	Male	43.5	72	Severe	55	<1	<55	<1	N/A

Table 2

Baseline	Intervention	Generalization	Maintenance
• Four multi-step requesting probes and four generic small talk probes administered by FCP and experimenter • No systematic instruction given	• Four multi-step requesting probes and four generic small talk probes administered by experimenter • Least to most prompting (e.g., constant time delay of 3 sec, verbal prompt, gestural prompt, physical guidance of the participant's hand) given.	• Four multi-step requesting probes and four generic small talk probes administered by FCP • New preferred activities and snacks introduced • No systematic instruction given	• Four multi-step requesting probes and four generic small talk probes administered by FCP and experimenter • No systematic instruction given