AN EVALUATION OF BACKWARD CHAINING TO TEACH A MAND TOPOGRAPHY USING A SPEECH GENERATING DEVICE TO CHILDREN ON THE AUTISM SPECTRUM

by

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(Under the Direction of Rachel Cagliani)

ABSTRACT

Children diagnosed with autism spectrum disorder (ASD) often present with language and communication difficulties (American Psychiatric Association, 2013). Speech generating devices (SGD) in combination with behavioral intervention packages, have been utilized to develop communication skills of children with ASD and other developmental disabilities (Muharib et al., 2019). The current study evaluated the efficacy of a novel backward chaining procedure to teach multi-step requesting using an SGD. Three male children with ASD were systematically introduced to a communication device using a multiple probe across participants design. Results indicated that the intervention was effective and maintained for two of the three participants. Implications for clinical application of study findings and future research are discussed.

INDEX WORDS: Speech Generating Device, Autism, Augmentative and Alternative Communication

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CHAPTER 1

INTRODUCTION

Children diagnosed with autism spectrum disorder (ASD) often present with language and communication difficulties (American Psychiatric Association, 2013). Although the presentation of communicative difficulties varies considerably, a significant proportion of children with ASD experience difficulties acquiring spoken language (Brignell et al., 2018). Specifically, researchers estimate that 30% of individuals with ASD do not develop functional spoken language (Shillingsburg et al., 2023). Instead, children may rely on pre-linguistic behaviors such as pointing or reaching, or engage in challenging behavior such as aggression, tantrums, or self-injury, in an attempt to communicate (Van Der Meer & Rispoli, 2010). A lack of effective communication skills could impede an individual's ability to convey their most basic needs, develop meaningful social relationships, and have long-term impacts on critical skills such as academic achievement and vocational accomplishment (Reichle et al., 2019). Thus, for individuals who are unable to use speech as their primary mode of communication, augmentative and alternative communication systems (AAC) can be used to promote communication (Mirenda, 2014).

AAC refers to an area of educational and clinical practice that aims to supplement an individual's natural speech through unaided or aided systems (Schlosser & Koul, 2015). Unaided AAC systems do not require external equipment (e.g., manual sign) whereas aided systems require a device or aid that is external to the user's body (e.g., picture-exchange systems, voice output communication aids; Agius, 2016). Researchers indicate that for children diagnosed with

ASD, the most effective AAC tools are the Picture Exchange Communication System (PECS; Frost & Bondy, 2002) and speech generating devices (SGD; Simeoli et al., 2024).

PECS is an instructional method designed to teach an aided communication system via picture boards (Bondy, 2012). The PECS training protocol consists of six sequential phases to teach requesting via the selection/exchange of picture cards and starts by teaching specific icons that represent preferred items/activities (Frost & Bondy, 2002). Support for PECS is considerable for individuals who present with limited communicative repertoires (Gilroy et al., 2023). However, comparisons of app interventions to PECS, reveals limitations (Gevarter et al., 2016). Specifically, individuals may not advance to making specific requests and other communication responses through PECS (Forbes et al., 2024).

A review of single-case PECS studies conducted by Forbes et al. (2024) found that one-approximately one-half to two-thirds of participants did not appear to master Phases IIIb, V, and VI, a concern because Phase IIIb is when learners begin to communicate specific messages (Forbes et al., 2024). In addition, participants who were taught Phase IIIb completed the phase by selecting from an array of three symbols (e.g., number of different requests possible at a given time, Forbes et al., 2024). Given these limitations, adapting the PECS protocol for teaching with SGD-based interventions to develop communication skills may be one option demonstrated to be effective (Alzrayer, 2020).

Speech generating devices (SGD) are electronic communication systems that contain symbols representing a sound, word, or phrase, and generate digitized voice outputs/messages (Genc-Tosun and Kurt, 2017). When a user touches or activates a symbol on an SGD, the verbal label of the relevant symbol is activated (Genc-Tosun and Kurt, 2017). The current widespread availability of portable electronic devices with AAC apps provides users with a small, easy to

transport, readily available, and socially acceptable means of communication (Shane et al., 2012). However, there is a need for further evaluation of the use of apps as well as display formats to teach requesting for specific items among multiple symbols, constructing sentences, and navigating through multiple pages (Alzrayer, 2014; Gevarter et al., 2016). Regardless of the form of AAC system, interventions are multifaceted and do not enhance communication unless combined with an appropriate instructional approach (Iacono et al., 2016, Shane et al., 2012). Despite research support for the use of behavioral strategies to teach requesting with apps, there is not one specific evidence-based SGD protocol for children with ASD (Gevarter et al., 2016).

Behavioral intervention packages in combination with speech-output technologies have been utilized to develop communication skills of children with ASD and other developmental disabilities (Muharib et al., 2019). Behavior chains are a common method used to teach complex skills with multiple steps to individuals with ASD and other developmental disabilities (Kobylarz et al., 2020). There are three widely used types of chaining: backward chaining, forward chaining and total task presentation (Spooner & Spooner, 1984). The application of chaining is the sequence or order in which the components are taught (Spooner & Spooner, 1984). Procedures that target untrained steps vary and may include the implementer completing untrained steps, using physical guidance, or a systematic prompt-fading hierarchy (Kobylarz et al., 2019). Backward chaining involves teaching the final step of the task analysis initially and progressively teaching early components (Slocum & Tiger, 2011). As earlier steps are added, all previously taught steps and the current step are required to be accurately completed in order to be considered correct and result in reinforcement delivery (Slocum & Tiger, 2011). SGD activation often requires multiple steps and therefore, chaining procedures should be considered when programming for instruction.

However, there is a need to conduct further studies to evaluate the effectiveness of behavior-analytic strategies in implementing AAC interventions (Muharib et al., 2019).

One study conducted by King et al., (2014) evaluated the efficacy of backward chaining procedures to teach children with ASD how to ask for preferred items using an SGD. The purpose of the study was twofold: to determine if adapting the PECS framework was effective for teaching requesting skills using an SGD and to evaluate if vocal requests increased following implementation of the iPad with the communication application. The results of the study support pre-existing teaching methods (i.e., PECS) for teaching requesting skills using instructional procedures founded in the principles of applied behavior analysis (ABA) (e.g., backward chaining; King et al., 2014). Furthermore, the results demonstrated the utility of technology (e.g., iPad with a communication app) as an alternative to engaging in challenging behavior (King et al., 2014). However, like previous findings, the participants in this study could not complete Phases IIIb and V (King et al., 2014).

SGD instruction involves a behavior chain that would benefit from systematic instruction embedded in chaining procedures. Although research findings demonstrate the efficacy of AAC for individuals diagnosed with ASD, instructional teaching procedures for successful implementation are warranted. Therefore, the purpose of this investigation was to evaluate backward chaining procedures to teach multi-step requesting using an SGD to children diagnosed with ASD. The specific questions asked were: are backward chaining procedures effective for teaching multi-step requesting using an SGD? And is backward chaining an effective method to teach multi-step requesting using an SGD when introduced in a larger visual field (i.e., 42)?

CHAPTER 2

METHODS

Participants

Participants included three children diagnosed with ASD, referred to an academic medical facility for communication and language delays. Inclusion was based on the following criteria: (a) caregiver/behavioral service provider reported limited to no functional communication skills (e.g., vocal verbal, but unintelligible, engages in challenging behavior as a means of communication such as crying, whining, or disrupting), (b) no prior learning history of using a tablet-based SGD, (c) caregiver/provider reported up to five preferred items. Only children diagnosed with ASD were selected for participation, as inclusion would be inconsistent with the research question. The first three participants identified who were referred and met criteria were included in this study. Furthermore, each participant was receiving behavioral treatment services at the time of inclusion in the current study. Once ethical clearance was obtained from the institutional review board, written informed consent was obtained from each participant's caregiver. Given that limited to no functional communication skills was an eligibility criterion for inclusion, participants themselves were not asked to assent or not assent.

Roman was a 5-year-old African American boy diagnosed with ASD. At the start of the study, he had been receiving 30 hours/week of intensive behavioral services for 4 months. William was a 5-year-old boy diagnosed with ASD, receiving 30 hours of intensive behavioral services per week. At the start of the study, William had been receiving services for approximately 3 months and 1 week. Chase was a 6-year-old African American boy diagnosed

with ASD. Prior to the study, Chase received 15 hours/week of behavioral treatment services for approximately 1 month. All participants were reported to communicate using picture exchange.

Figure 1 provides a breakdown of each participant's scores across The Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP; Sundberg, 2008). The VB-MAPP is a criterion referenced assessment tool used to evaluate the language and social skills for individuals aged 0-48 months (Padilla, 2020). In addition, the VB-MAPP Barriers Assessment tool was used to determine learning and language acquisition barriers (Sundberg, 2008). Results of the barriers assessment for each participant are summarized in Table 1.

Setting and Materials

The current study took place at an academic, medical facility providing treatment for individuals ages 2 to 22-years-old diagnosed with ASD and/or developmental delays, located in the southeast, United States. All sessions took place in the participant's designated area within the research classroom, consisting of a table, chairs, and additional neutral/moderately preferred items (i.e., not included in the preference assessment). Additional individuals receiving services at the same facility were present during research sessions but were not directly involved in any part of the procedures. The primary researcher conducting sessions was enrolled in a graduate program in ABA and was a Board-Certified Assistant Behavior Analyst (BCaBA), with 9 years of applied experience. Individuals assisting with data collection were Registered Behavior Technicians (RBT), Board Certified Behavior Analysts (BCBA), and doctoral level Board Certified Behavior Analysts (BCBA-D).

All sessions took place at a table, with the researcher within arm's reach of the participant for prompting purposes. A 6th generation Apple iPad Version 16.6.1 programmed with the downloadable communication application was used as the SGD for William and Chase. Roman

used a prescribed Samsung device with the TouchChat app. TouchChat, a customizable application designed by Gail Van Tatnehove, PA, MS, CCC-SLP, offers a solution for individuals who do not acquire vocal verbal skills naturally (TouchChat, n.d.). The SGD was programmed to display 42 picture icons per page. Figure 2 shows the TouchChat app's home display screen for the selection of the verb icon. After selecting the verb icon, a subsequent screen for the selection of the noun icons appeared. However, layout and formatting remain the same. In addition, the SGD was programmed to display each participant's target item, based on the results of the preference assessment. Additional materials included data sheets, writing utensils, and a video camera to record sessions.

Dependent Variable

The dependent variable was independent multi-step requests. Data were collected for both steps of the multi-step request, activating a button with a verb such as "eat" and activating a button with a noun such as "chips", based on participant responding. The percentage of independent steps was calculated by dividing the total number of independent responses by the total number of opportunities. During baseline sessions, data were collected to determine if the participant completed all steps of the backward chain independently. A trial began following the participant's indicating response (e.g., pointing, reaching, picture exchange) for the target item. If the participant used the SGD within 5s of indicating and selected the corresponding verb (e.g., eat) icon, an independent response was scored for the selection of the verb. If the participant also selected the corresponding noun (e.g., chips) icon within 5s of indicating, an independent response was scored for the selection of the noun. An error was scored if the participant selected the incorrect verb or noun icons within 5s following an indicating response. No response was

scored if the participant did not attempt to navigate the SGD within 5s following an indicating response.

Data Collection

Data were recorded using a prepared data sheet and pen/pencil. Data collectors documented the topography of the participants' indicating response (e.g., pointing, reaching, picture exchange), the preferred item indicated for, and whether the item was consumed. The data sheet also included the steps of the backwards chaining procedure for researchers to document participant responding as it pertained to selecting the verb and noun icons. During phase one, independent responding was recorded if the participant used the SGD to select the corresponding noun icon within 5s of the participant's indicating response. An error was scored if the participant selected the incorrect noun icon or navigated to the wrong page of the SGD. No response was scored if the participant did not use the SGD within 5s following an indicating response. During phase two, independent responding was recorded if the participant used the SGD to select the corresponding verb and noun icons within 5s of an indicating response. An error was scored if the participant selected the incorrect verb or noun, or navigated to the wrong page of the SGD. No response was scored if the participant did not use the SGD to request the target item within 5s of an indicating response.

Interobserver Agreement and Treatment Fidelity

Interobserver agreement (IOA) was recorded for 50% of the sessions conducted with Roman, 31% for William, and 46% for Chase, across all study phases. The data collectors independently recorded and scored the participant's responses. IOA was calculated using point-by-point agreement. The primary researcher compared the two observers' trial-by-trial data to calculate the total number of agreements, then divided that number by the total number of

agreements plus the total of disagreements, multiplied by 100 for a percent of agreement. The average agreement was 97.8% for Roman, 95.72% for William, and 99% for Chase.

Training for data collectors consisted of reviewing and reading the protocols, discussing the procedures with the primary researcher, observing the primary researcher implementing procedures, role-playing both baseline and intervention procedures, and providing ongoing feedback from the primary researcher. All observers were trained in baseline and intervention procedures and completed role-play checklists prior to implementing the procedure.

Procedural fidelity was scored with a checklist that consisted of all the procedural steps necessary for correct implementation of the study phases. Study implementers were trained in baseline and intervention procedures, evaluated procedural fidelity, and data collection methods. Ninety-nine percent (range, 89%-100%) procedural fidelity was recorded for 24% of all sessions conducted with Roman, 100% procedural fidelity for 20% of sessions conducted with William, and 100% procedural fidelity for 31% of sessions conducted with Chase.

Experimental Design

A multiple probe design across participants was used non-concurrently, to evaluate the effects of backward chaining procedures to teach multi-step requesting using an SGD to children diagnosed with ASD. The multiple probe design includes intermittent data collection prior to the introduction of the intervention (Ledford & Gast, 2018). Once baseline data were stable for a participant, intervention procedures were implemented. Due to recruitment barriers, participants did not begin baseline sessions on the same day, however intervention procedures were introduced in a staggered manner. Once a treatment effect was demonstrated for one participant, baseline procedures were implemented for the next participant.

Procedures

Researchers conducted indirect assessments prior to conducting a formal preference assessment. The indirect assessment consisted of interviews with adults who were familiar with the participants (e.g., caregivers, behavioral treatment providers), gathering information about items the participant engaged with most often, how they recruited attention or indicated for an item, and any relevant information pertaining to meeting the child's communicative needs (e.g., challenging behaviors if request wasn't fulfilled). The primary researcher also attended participants' daily treatment sessions to assess current communicative methods, specific items indicated for within the research setting, and the contexts where the behavior was more or less likely to occur (e.g., time of day). Figure 3 outlines the progression of study phases.

Preference Assessment

A multiple stimulus without replacement (MSWO) preference assessment (DeLeon & Iwata, 1996) was administered prior to beginning the study. Researchers identified six preferred edibles for each participant through direct and indirect observations (e.g., caregiver report). An MSWO was conducted prior to conducting formal sessions, to determine participants' hierarchy of preferred edibles. The targeted verb for all participants was "eat." Target nouns were Mini-Starbursts (Roman), mango (William), and Golden Oreos (Chase).

Baseline

The purpose of baseline sessions was to evaluate participant responding for all steps of the backwards chaining procedure. The researcher placed 4-6 edibles on a table within the participant's view but out of reach. The SGD was also positioned on the table with an open display screen of the TouchChat home page consisting of 42 icons. Three baseline sessions were conducted to assess each participant's use of an SGD to request a preferred item using the

corresponding verb and noun. Following an indicating response (e.g., pointing, reaching), the researcher blocked access to the item and waited 5s for the participant to request using the SGD. If the participant independently requested with the SGD using the corresponding verb and noun of the item indicated for, the researcher removed the SGD and delivered one piece of the edible. If the participant made an error (e.g., selected the incorrect icon), the researcher immediately removed the SGD and delivered one piece of the edible. If the participant did not attempt to navigate the SGD within 5s following an indicating response, the researcher removed the SGD and delivered one piece of the edible. If the participant indicated for two items simultaneously, items were rearranged and another opportunity to provide an indicating response was given. As soon as the participant indicated for an item, all the other preferred items were removed from reach. Regardless of the participant's response, the researcher did not use any prompting procedures or interact with the participant, outside of delivering reinforcement during baseline sessions.

Teaching Sessions

The purpose of errorless teaching sessions was to teach the participant the entire chain of responding while using a zero second prompt delay. Three sessions consisting of three trials were conducted for all participants. Following the participant's indicating response for the target item, the researcher immediately used hand-under-hand prompting to select the corresponding verb and noun icons on the SGD. The physical prompt was selected based on recommendations from speech-language pathologists and based on participant's VB-MAPP scores, particularly in the imitation domain. Additionally, the opportunity to independently request was provided during treatment sessions and modified for two of the three participants due to prompt

dependence. Once three sessions consisting of three trials were conducted, the first terminal probe was conducted.

Terminal Probes

A terminal probe was conducted at the beginning of phase one and phase two to evaluate participant responding following errorless teaching sessions. Probe procedures conducted at the beginning of phase two were identical to procedures in phase one. The probe session consisted of three trials. Participants were given the independent opportunity to complete all steps of the backward chaining procedure following an indicating response for the target preferred item. If the participant did not request within 5s following an indicating response, or errored (e.g., navigated to the wrong page on the SGD, or selected the incorrect verb or noun icon), the trial ended, and phase one procedures were implemented.

Phase One

The purpose of phase one sessions was to evaluate participant responding for the final step of the backwards chaining procedure while using a 5s prompt delay. A trial began when the participant indicated for the target preferred item, the researcher blocked access and immediately used hand-under-hand guidance to select the corresponding verb icon on the SGD. For the final step of the backwards chaining procedure, the participant was given 5s to independently select the corresponding noun icon on the SGD. If the participant made an error (e.g., selected the wrong noun or navigated to the wrong page), the researcher utilized hand-under-hand guidance to select the corresponding noun icon and scored error on the data sheet. If the participant did not use the SGD within 5s following an indicating response, the researcher utilized hand-under-hand guidance to select the corresponding noun icon and scored no response.

Phase Two

The purpose of phase two sessions was to evaluate participant responding for completing all steps of the backward chaining procedure while using a 5s prompt delay. A trial began when the participant indicated for the target preferred item. The researcher blocked access and waited for the participant to make an error (e.g., selecting the incorrect verb), or until 5s elapsed without any attempt to navigate the SGD before using hand-under-hand guidance to prompt the correct response. An independent response was scored if the participant used the SGD within 5s of indicating for the preferred item and selected the corresponding verb and noun icons.

Maintenance

Following mastery of phase two procedures, maintenance probes were conducted for each participant. The duration between completion of phase two and the maintenance probes varied across participants. However, maintenance of multi-step requesting using an SGD was evaluated two- and four-weeks post mastery for all participants. The procedures for maintenance sessions were identical to terminal probe sessions. Participants were given the opportunity to request using the corresponding verb and noun icons of the item indicated for on the SGD.

Figure 1 Participant VB-MAPP Milestones Score

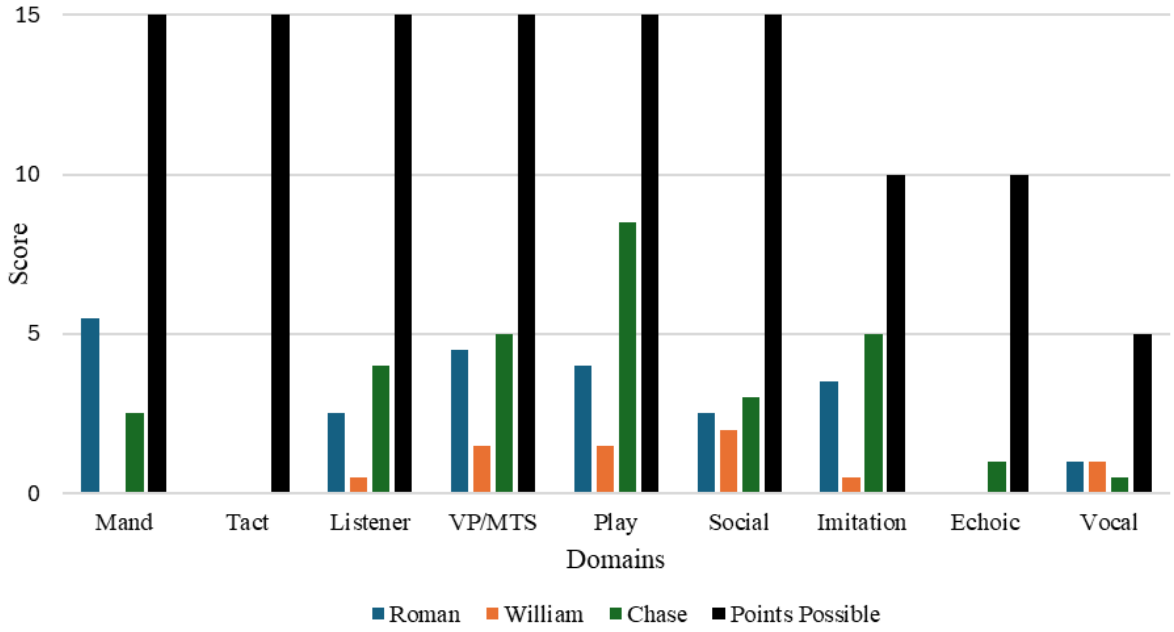


Table 1 Participant VB-MAPP Barriers Assessment Score

Barriers	Roman	William	Chase
Behavior Problems	1	2	0
Instructional Control	2	2	0
Impaired Mand	3	0	2
Impaired Tact	0	0	0
Impaired Echoic	4	0	2
Impaired Imitation	3	2	0
Impaired VP-MTS	4	0	0
Impaired Listener	4	0	0
Impaired Intraverbal	0	0	0
Impaired Social Skills	0	0	0
Prompt Dependent	2	0	1
Scrolling	0	3	0
Impaired Scanning	0	0	0
Impaired Conditional Discrimination	0	0	0
Failure to Generalize	0	0	0
Weak Motivators	2	0	1
Response Requirement Weakens MO	3	0	1
Reinforcer Dependent	2	0	2
Self-Stimulation	2	1	0
Impaired Articulation	0	0	0
Obsessive-Compulsive Behavior	0	0	0
Hyperactive Behavior	2	2	1
Failure to Make Eye Contact	1	1	2
Sensory Defensiveness	0	0	0
Total Barriers Score	35	13	12

Figure 2 TouchChat Display Screen

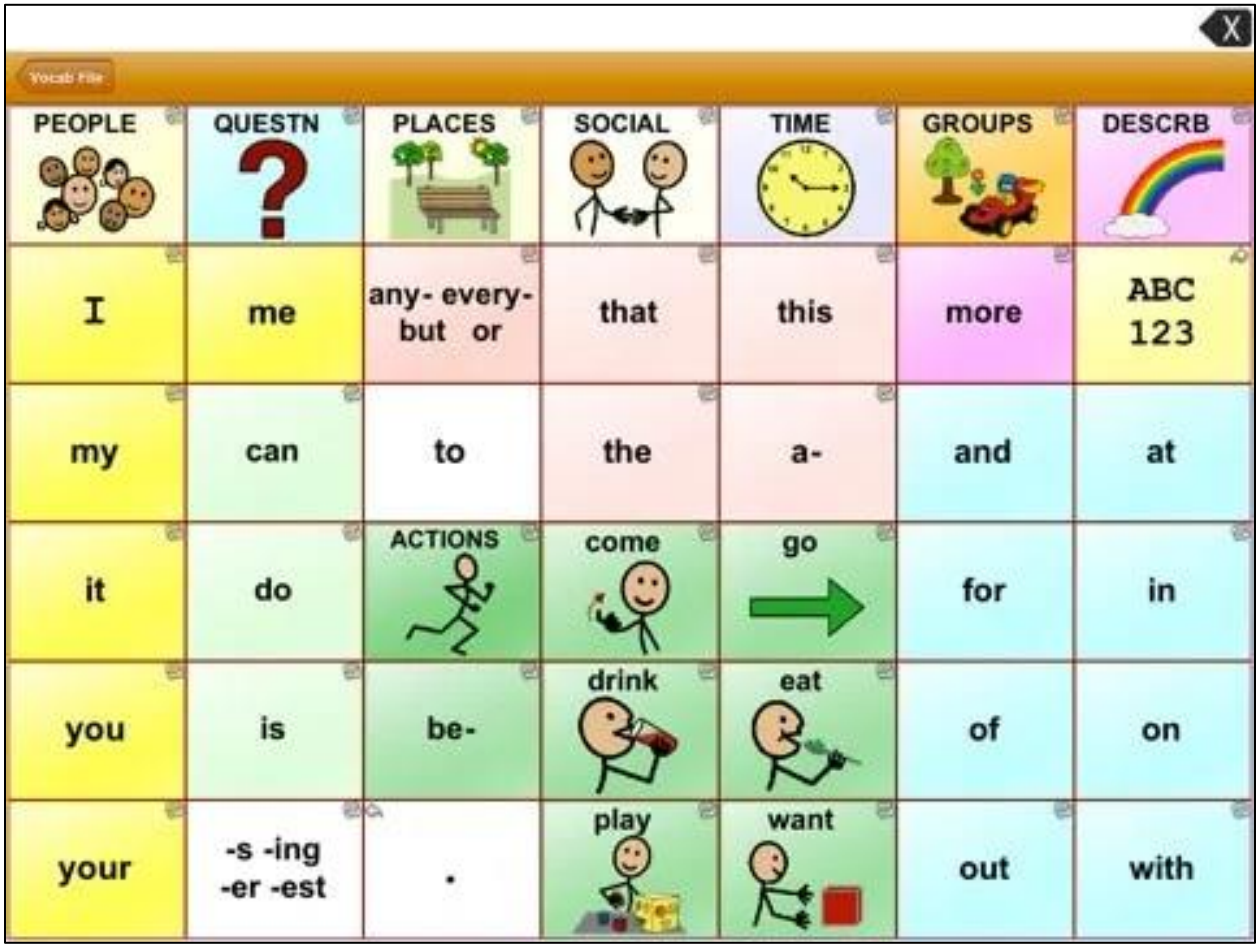
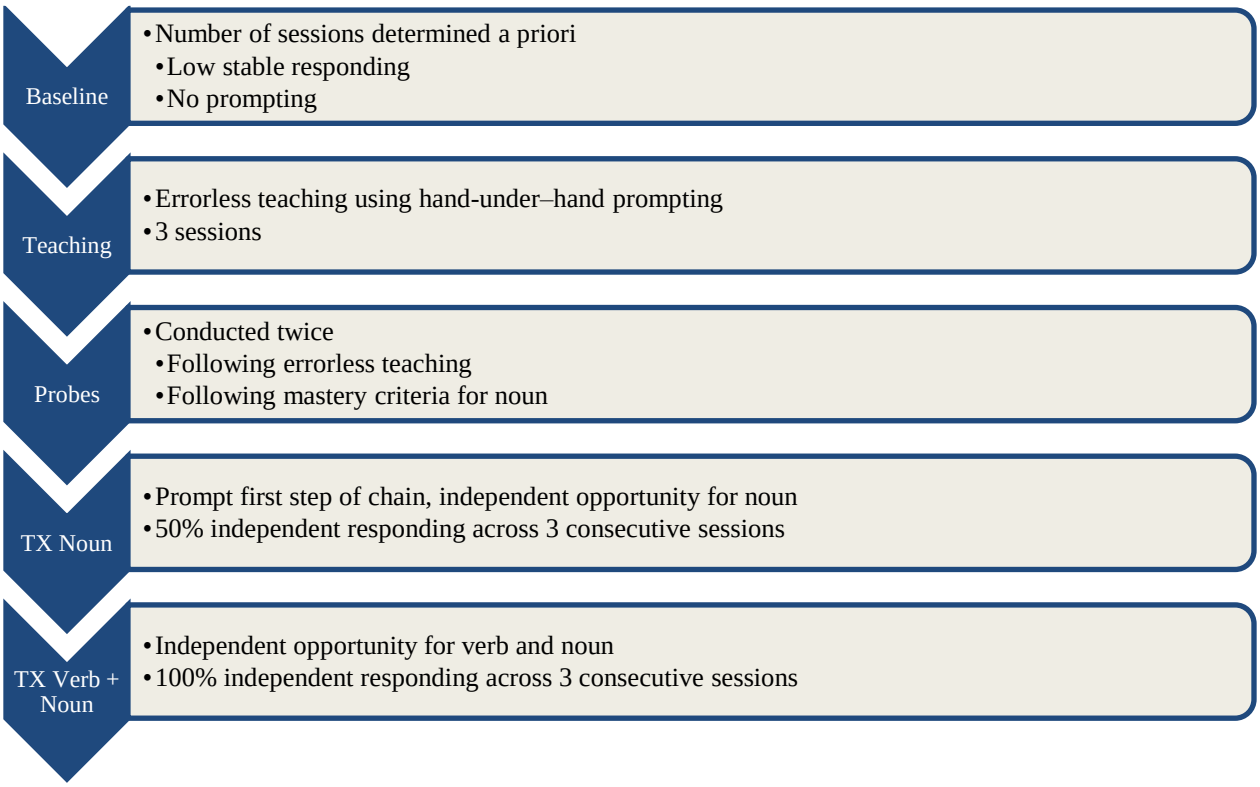


Figure 3 Study Phase Progression



CHAPTER 3

RESULTS

Figure 4 depicts the percentage of independent correct steps across baseline, intervention, and maintenance conditions for Roman, William, and Chase. The baseline and intervention data demonstrate a functional relation between backward chaining procedures and multi-step requesting using an SGD for two of the three participants. In baseline, Chase was the only participant who used the SGD to request, however, independent responding did not maintain during subsequent sessions. The implications of the study findings are discussed in the subsequent chapter.

Roman

The top panel of Figure 4 depicts the percentage of Roman's independent steps during baseline, intervention, and maintenance conditions. During baseline, Roman did not engage in multi-step requests using the SGD. The next condition shows intervention following the teaching of the backward chain for multi-step requests. Upon errorless teaching, the probe and intervention data show that responding did not change. Immediately following a procedural modification, responding immediately increased, demonstrating a functional relation between the intervention and the dependent variable. A total of 28 sessions were conducted before mastery criteria was achieved for independent selection of the noun icon using the SGD. During the final probe, Roman did not engage in the target response. However, when intervention was reintroduced targeting both steps of the chain, responding immediately increased to levels observed in the previous treatment condition. Independent selection of both the verb and noun

icons using the SGD were targeted for 11 sessions. Following mastery, multi-step requesting was evaluated for a novel noun (i.e., untrained) using the SGD. Roman's second highest preferred edible was used as the target noun, however he did not engage in the target response. Independent multi-step requesting was evaluated two-and four-week post mastery and maintained for Roman.

William

The second panel in Figure 4 shows the percentage of independent steps for William. A total of six baseline sessions were conducted before initiating intervention procedures. Immediately following intervention targeting the noun, responding immediately increased, however William was not selecting the corresponding noun icon of the target item. In the final sessions using hand-under-hand prompting, response errors decreased. A gesture prompt was then implemented, since William began to display signs of prompt dependence, similar to Roman (e.g., grabbing researchers' hand). However, following the prompt modification, William's errors increased at a steady rate. The research team then modified the size of the icons to evaluate participant responding. When no observed changes in William's multi-step requests occurred, another increase in icon size was implemented. Following 11 sessions of increasing the size of the icons on the SGD and no observed changes in independent multi-step requests, a third increase in icon size was implemented. During the third modified size sessions, William's errors increased. After nine sessions, the research team changed the three bordering icons that surrounded the target noun icon (i.e., mango) to non-preferred icons. Since antecedent manipulations were not effective, researchers implemented consequence-based strategies by delivering the item, even if it wasn't the target edible. Independent responding immediately increased, but only for the first two sessions. This pattern of responding was similar during

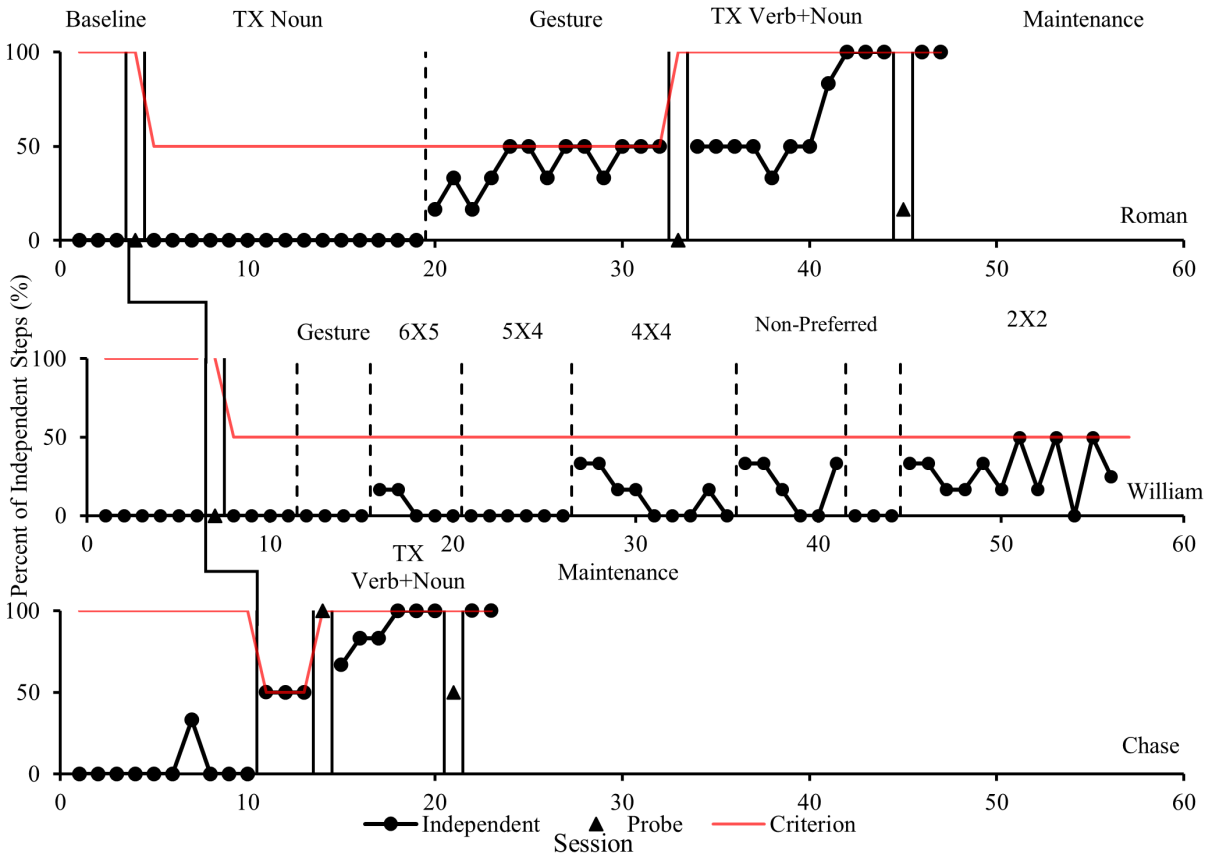
previous conditions (i.e., first and third icon size increase conditions), however, independent responding did not maintain. The next modification consisted of changing all noun icons to non-preferred edibles, compared to just the three surrounding icons in the previous session. Errors in responding immediately increased across three sessions. The final intervention modification consisted of reducing the visual field to just include four icons. Independent responding immediately increased during the first two sessions, however, during the third session, errors increased. During this time the research team was informed that due to changes in treatment providers, some information was not correctly reported. For instance, caregivers reported William was not reliably using picture exchange. These reports were confirmed amongst William's treatment team and evident in his daily sessions when the treatment team returned to establish pointing before working resuming picture-exchange. After discussing the number of procedural modifications with William's caregivers and treatment team, and due to a lack of effective procedures demonstrated by the data, William was excluded from the current study.

Chase

Chase demonstrated independent requesting during baseline, however responding decreased in subsequent sessions. Following errorless teaching, researchers made a procedural integrity error and did not conduct the first terminal probe session. However, responding during treatment for the noun demonstrates a functional relation given the immediate change in the level of responding. Chase met mastery criteria for selecting the target noun within the first three sessions. Interestingly, during the probe session, Chase completed both steps of the chain and independently selected the corresponding verb and noun icons. However, upon reintroduction of intervention, independent responding initially decreased. A total of six sessions were conducted before mastery criteria was achieved for the independent selection of the verb and noun icons.

The primary researcher conducted a probe session using a novel preferred item (i.e., determined by MSWO) to evaluate multi-step requesting using a different noun. Although responding decreased when evaluated using a novel noun, multi-step requesting maintained during the two- and four-week post mastery sessions.

Figure 4 Percent of Independent Steps



CHAPTER 4

DISCUSSION

The present study was designed to evaluate the effects of backward chaining procedures to teach multi-step requesting using an SGD to three children with ASD. The present study was also designed to determine the efficacy of backward chaining procedures to teach a mand topography when introduced in a visual field of 42. During baseline, participants did not demonstrate independent multi-step requesting using an SGD (e.g., eat candy). Following intervention, Roman and Chase met mastery criteria within 10-14 sessions for the independent selection of corresponding verb and noun icons to request a preferred item. The results suggest a functional relation between the intervention procedures and increased multi-step requesting. The findings are consistent with previous findings supporting backward chaining procedures to increase multi-step requesting for children with ASD (King et al., 2014).

Moreover, the findings offer preliminary support for the use of backward chaining procedures to teach multi-step requesting using an SGD when introduced in a larger array (i.e., 42). Although William did not demonstrate the acquisition of the target skill, the research team was later informed that he was not reliably using picture exchange at the time of inclusion. This suggests that, for some children with ASD and developmental disabilities, pre-requisite skills should be considered before SGD instruction.

Furthermore, the procedural modification to change from a hand-under-hand prompt to a gesture prompt during Roman's sessions for the target noun, suggests hand-under-hand prompting may not be necessary for all individuals. Future studies should continue to evaluate

various prompting methods and procedures to determine the least intrusive prompt required to evoke the correct response. Future researchers should also consider replicating intervention procedures across varying learner profiles, across individuals who have prior experience with different communication apps and across different modalities of AAC systems.

During baseline sessions, none of the participants used the SGD to request using a verb noun phrase (e.g., drink water). Following intervention, two of the three participants met mastery criteria within 10 to 14 sessions. The implications of the findings from this study are important because it demonstrates backward chaining is an effective method for teaching multi-step requesting using an SGD. These findings are significant in at least two major respects. Very little was found in the literature on the question of backward chaining procedures to teach multi-step requesting using an SGD to children with ASD. Additionally, limited reports were found on the association between teaching multi-step requesting using a visual field of more than four icons. Previous studies focused on teaching multi-step requesting using an SGD have typically used visual fields consisting of one to four items, whereas this study evaluated procedures using an array of 42 picture icons.

While the results suggest an effective approach for teaching multi-step requesting using an SGD, there are some limitations. First, the research team did not evaluate multi-step requesting for an untrained item during baseline sessions for any of the participants selected for inclusion. Therefore, the novel noun session following mastery criteria of the backward chain cannot be considered generalization, since it is unknown if the participant demonstrated the skill of requesting prior to intervention. Thus, future studies should evaluate backward chaining procedures as it pertains to generality across varying verbs, nouns, contexts, and communicative partners.

Future studies should evaluate the use of different prompts to determine if the rate of acquisition varies across different prompts. Additionally, future research should systematically replicate this study using backwards chaining procedures but across varying visual fields. Future studies should also evaluate backwards chaining procedures compared to other teaching procedures currently utilized to introduce SGD to individuals with ASD.

Despite these limitations the current investigation demonstrated that backward chaining procedures are effective in the acquisition of multi-step requesting using an SGD for children with ASD. The insights gained from this study may be of assistance to practitioners working with individuals diagnosed with ASD and other developmental delays, specifically targeting requesting skills.

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