



Establishing Peer Manding in Young Children with Autism Using a Speech-Generating Device

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Abstract

Impairment in social communication is a hallmark characteristic for individuals with a diagnosis of autism. As such, specific instructional strategies that incorporate the use of augmentative and alternative communication (AAC) system, such as an iPad® based speech-generating device (SGD) is often indicated. This study evaluated the use of the *interrupted chain* procedure in the establishment of peer manding for three young children with a diagnosis of autism. The procedures involved the presentation of a task related activity (i.e., puzzle) and the neuro-typical peer interrupted the behavioral chain of task completing by withholding the final piece needed to complete the task. An iPad® based SGD was used as an AAC for the participants to mand for the missing item needed to complete the task related activity from the peer. Additionally, a five-second-time delay with full physical prompts was used for instructional purposes. The results indicated that all three participants acquired the ability to mand for the missing item from the peer, and this skill was also found to maintain following training.

Keywords Autism · Mand · Peer · Social interaction · Speech-generating device

Social communication impairments are one of the hallmark features resulting in a diagnosis of autism (American Psychiatric Association [APA] 2013). Impairments in social communication skills can include challenges with greeting others, initiating and reciprocating social interaction, engaging in joint attention, and/or using appropriate body language (APA, 2013). Marked impairments in social communication can hinder an individual's ability to develop and/or maintain relationships, which underscores the need for interventions to address these deficits (Boyd et al. 2015). It is estimated that 30% of individuals with autism do not acquire functional vocal output capabilities (Wodka, Mathy, & Kalb, 2013). This highlights the necessity of developing strategies to increase social communication, including peer interaction, using augmentative and alternative (AAC)

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methods of communication. The literature has demonstrated that various forms of AAC, including the Picture Exchange Communication System (PECS) and speech-generating devices (SGD), can be used to teach verbal behavior to individuals with autism.

One of the earliest forms of verbal behavior to be acquired is the *mand*, which was first described by Skinner (1957) as behavior in which the speaker requests or demands an item or activity of a listener. A mand is reinforced by the speaker receiving the item/activity, and is under the control of a condition of a state of deprivation that acts as an establishing operation [EO] (Shafer 1994). Because the mand is one of the first forms of verbal behavior acquired, it is often necessary to teach manding as one of the first skills in a verbal behavior development plan for individuals with autism (Albert et al. 2012).

An aspect of mand instruction that has received limited exploration in the literature is that of peer manding. Because of the social communication deficits that are a hallmark of the diagnosis, individuals with autism often require systematic instruction to engage in peer interaction. Frequently, children with autism who engage in manding directed toward adults do not emit mands to peers unless this skill is taught explicitly (Pellecchia and Hineline 2007; Taylor et al. 2005). Therrien, Light, and Pope (2016) conducted a systematic review of AAC interventions targeting peer interaction, in which they found that prior to intervention, 89% of social interaction of children studied was with adults, and only 5% was with peers. A few studies on peer manding focused exclusively on manding using AAC, though most exclusively dealt with PECS (Bondy and Frost 1994), rather than SGD.

In a systematic review investigating the efficacy of various types of peer support, the authors reviewed 18 studies in which any one of four types of peer support interventions were used (Chapin et al. 2018). The four types of interventions reviewed were the peer providing prompting for, being in close proximity to, initiating interaction with, and/or providing reinforcement for the participant with autism. The authors calculated the effect sizes of each of the four types of peer support, and observed a very large effect size for the studies in which a peer provided reinforcement for the behavior of a child with autism. A large effect size was observed for teaching peers to initiate interaction with children with autism and for peers providing prompting, and a moderate effect size was observed for teaching the peers to engage in proximity-related behaviors (Chapin et al. 2018).

Doherty et al. (2018) reported two studies involving peer manding using PECS. In their first study, preschoolers with autism were taught to mand to peers who also had an autism diagnosis. In the second study, preschoolers were taught to respond as listeners by fulfilling mands from peers. Systematic prompting and reinforcement were found to be effective interventions for increasing peer mands and for increasing independent responding to mands from peers. These findings generalized to novel peers for the majority of the participants (Doherty et al. 2018). Another study on peer manding used differential reinforcement of alternative behavior (DRA) and reinforcement to increase independent PECS exchanges with peers (Paden et al. 2012). A DRA procedure involves no longer reinforcing a particular response (in this case, mands to adults), and instead reinforcing a specific alternative (mands to peers) (Cooper et al. 2007). The authors found that independent manding to peers increased for both participants in this study.

Various strategies can be employed to contrive manding opportunities, including the *interrupted chain procedure* (Shafer 1994; Carter and Grunsell 2001). The interrupted chain procedure is used to manipulate Motivating Operations/Establishing Operations (MOs/Eos) by contriving a state of deprivation and thus, evoking a mand. An EO is

defined as a stimulus that alters the value of a reinforcing stimulus, thereby making the reinforcing stimulus more valuable when the EO is present (Catania 2013; Shafer 1994). The presence of an EO increases the use of behaviors associated with accessing the reinforcing stimulus (Laraway et al. (2003). For example, food deprivation can be an EO that increases not only the value of food, but also the likelihood of engaging in behaviors that have previously led to the acquisition of food (i.e., stopping when one sees a sign for a fast food restaurant, or going grocery shopping).

In the interrupted chain procedure, the EO is manipulated by disrupting behaviors that have produced a reinforcing consequence for the individual in the past. In a behavior chain, each step reinforces the completion of the previous step, while serving as a discriminative stimulus (S^D) for the next step. When a behavior chain is interrupted, the value of completing the step is modified, thereby contriving an EO in order to evoke a mand (Shafer 1994). The interrupted chain procedure involves the withholding of a step needed to complete the behavioral chain, thereby directly contriving the EO (i.e., state of deprivation) for manding (Shafer 1994).

Several studies have successfully used a form of the interrupted chain procedure to teach vocal manding for missing items (Albert et al. 2012; Lechago et al. 2010; Howlett et al. 2011). Other studies have used the interrupted chain procedure to effectively teach requesting using AAC, usually PECS, PE, and/or manual sign. These studies involved using an interrupted chain procedure to contrive mands by blocking access to visible items (Lorah et al. 2014; Taylor et al. 2005), blocking access to missing items (Ribeiro et al. 2010; Rosales and Rehfeldt 2007; Sigafoos et al. 2013; Ziomek and Rehfeldt 2008), and/or contriving increased opportunities for a variety of mands (Sigafoos et al. 1994). Of these studies, only two used SGD. Taylor et al. (2005) included two participants who communicated vocally and one who used a SGD with voice output (DynaMyte™). Only one of the above studies (Sigafoos et al. 2013) used the iPad® with the Proloquo2Go™ application as a SGD.

The research on peer manding using PECS indicates that the use of systematic prompting and reinforcement may be an effective intervention for teaching individuals with autism to mand to their peers. However, there is a lack of research on teaching peer manding to those who use SGD. The current study sought to extend the literature on peer manding to include the use of the iPad® with the Proloquo2Go™ application. Furthermore, there is a lack of research reviewing the efficacy of an interrupted chain procedure to evoke mands with individuals using the iPad® as a SGD, in terms of peer manding.

Thus, the current study seeks to extend the SGD literature to assess if an interrupted chain procedure is an effective strategy for evoking peer mands when the targeted individual uses an iPad® with Proloquo2Go™ as a SGD.

Method

Participants

As depicted in Table 1, three preschool aged children all diagnosed with autism participated in the study. All three of the participants attended a four-week preschool group, three days per week, for 2.5 h per day, using the methodology of Applied Behavior Analysis. In total there were four children who attended the preschool

Table 1 Participant Information

Participant	Diagnosis	Age	VB-MAPP milestone scores	
			Social skills	Mand repertoire
Sally	Autism	3.9	4	9
Nate	Autism	3.6	1	8
Linda	Autism	4.2	4	7

learning environments. The participants were selected for participation in this study based on the following criteria: a) a primary clinical diagnosis of autism applied from an independent agency; b) between the ages of three-to-five; c) use of an iPad® based speech-generating device (SGD) as a primary means of communication; d) a limited to absent tact repertoire as measured by the *Verbal Behavior-Milestones Assessment and Placement Program Barriers Assessment* (VB-MAPP; Sundberg 2008); and e) a level two mand repertoire as measured by the VB-MAPP. All three of the participants had previously acquired the ability to mand and discriminate between more than 10-picture symbols on the screen of the iPad® SGD. The participants were previously identified as SGD candidates given his weak to absent mand and echoic repertoires.

Peers

Additionally, three male “neuro-typical” peers participated in this study. The peers had a mean age of three-years, six-months, and did not have a diagnosis of autism or a developmental delay. Peers attended the same preschool clinic setting in the role of a “peer mentor”. Prior to the onset of the clinic group the peers were trained on the procedures for the study and how to respond as a listener to mands using the iPad® based SGD. The training was conducted by the lead author who was also the clinic supervisor. Training lasted approximately 30-min and included general information on autism and communication strategies, as well as, how to respond to manding for a child using a SGD. Finally, the training included role playing where the researcher acted as the participant and manded for the missing item. Training continued until the peers demonstrated the ability to appropriately respond to peer mands at 100% independence and accuracy.

Materials and Setting

The materials included an iPad® Mini, generation two, and the application Proloqu2Go™, which was used as the speech-generating device. The iPad® Mini was covered in a protective case. The iPad Mini® was selected as the SGD within this study given its availability and affordability. For example, at the time of this writing, an iPad Mini® is available on Amazon for \$105 US Dollars, with two-day shipping included. This makes the device both affordable and readily available. During all sessions, the iPad Mini® was positioned within 7.62 cm, directly in front of or next to the participant. The screen of the iPad Mini® was arranged with three icons on the screen of the device, two icons that corresponded to the manding targets and one distractor icon. The digitized voice output of the device was set to “male child” and therefore matched the sex and age of the

participants. Sessions occurred during a task completion center where the participants were seated on an oval carpet with the teacher positioned in front of them, within 15.24 cm. Each of the participants had a 1:1 (therapist: student) instructor who was positioned directly behind them. During training this instructor acted as the interventionist providing prompting. The task related activity included a three-to-twelve piece, wooden island puzzle. The puzzle used varied from session to session, based on the child's task related interests (i.e., an animal puzzle, a vehicle puzzle, etc.).

Teacher and Interventionist

The head teacher within the preschool learning environment was a doctorate student in Curriculum and Instruction, at the university where the study took place. Additionally, the Behavior Analysis Certification Board™ as a Board Certified Behavior Analyst (BCBA) certified her. The 1:1 instructors/interventionists were master's degree level graduate students in Applied Behavior Analysis at the university where the study took place. Both the teacher and interventionists were trained on the procedures by the primary investigator, prior to the onset of the study.

Dependent Measurement

The dependent measurement system for this study involved the collection of probe data (either a yes response or a no response) in terms of independent manding. A selection-based (vs. topography based) mand was used as the dependent measure for this study, as this is consistent with the literature base for this population (see Lorah et al. 2015). The probe was scored as a "yes" if the participant selecting the visual icon on the screen of the SGD that corresponded with the item needed to complete the task (i.e., the puzzle) and the vocal output from the device was emitted. The probe was scored as a "no" if the participant either selected an incorrect icon on the screen of the device or did not respond within five-seconds of the presentation of the stimuli. There were 10 probes/trials per session, with two sessions occurring per instructional day. All data were converted to a percentage and graphed (see Fig. 1). The percentage was calculated by taking the number of independent responses and dividing that by 10 (the number of response opportunities), multiplied by 100. Data were collected by either the primary investigator or the classroom teacher.

Experimental Design

A multiple baseline across participants design (Ledford and Gast 2018) was used to evaluate the effects of training on the demonstration of independent manding. Training was introduced in a staggered format, following stability in baseline data.

Interobserver Agreement and Procedural Fidelity

Interobserver agreement (IOA) data were collected for 45% of trials, through the collection of data by both the primary investigator and the classroom

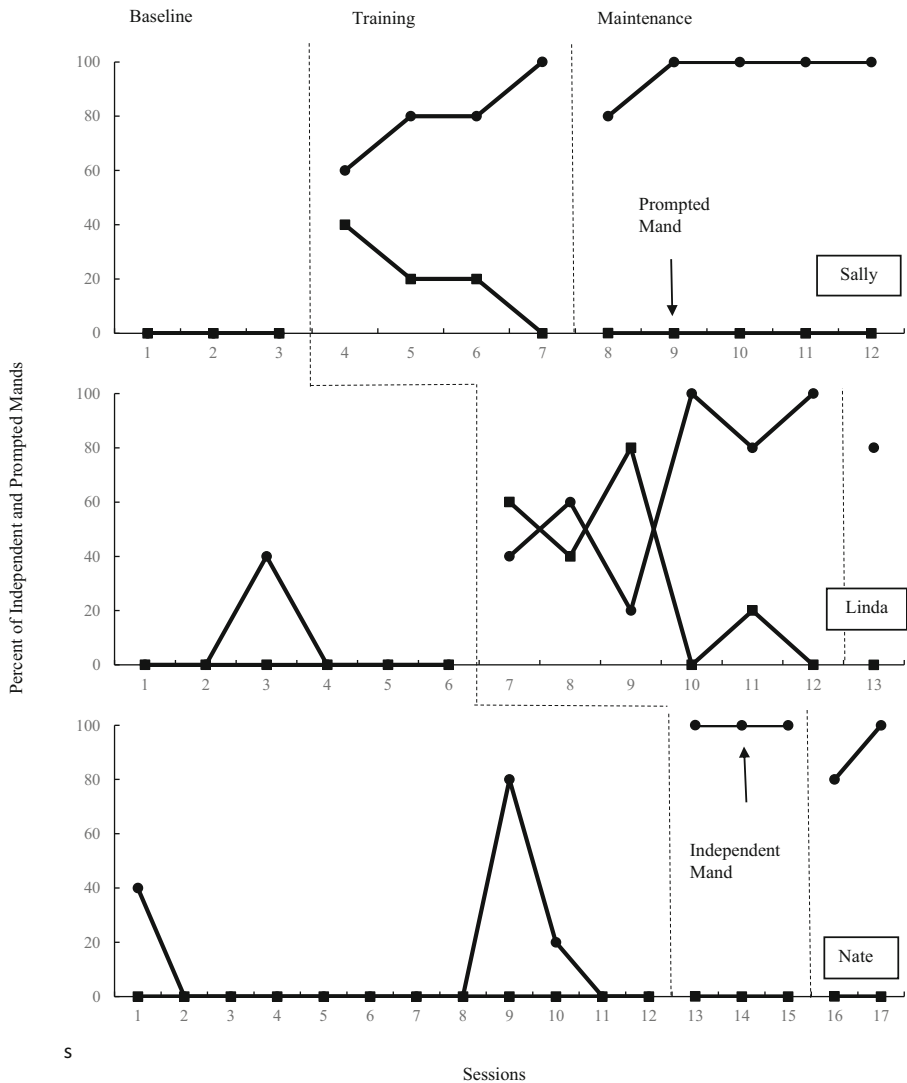


Fig. 1 Percentage of Mands. This figure depicts the percentage of independent and prompted mands across baseline, training, and maintenance

teacher. IOA was calculated by taking the number of agreements and dividing that by the number of agreements, plus disagreements, multiplied by 100. IOA was 100% for the dependent measure. Procedural fidelity was ensured through the collection of a self-reported fidelity probe by the interventionist following every session. The fidelity probes entailed the interventionists either circling a “yes” or “no” for five questions related to the procedures of the study. For example, one of the questions read “I provided prompting during baseline”. Fidelity probes indicated that the procedures were followed, as designed, for 100% of the trials. Additionally, the primary investigator was present for 90% of sessions to ensure fidelity of implementation.

General Procedures

All sessions were conducted in the “puzzle center” of the classroom (see setting for complete description). Sessions were broken into 10-trials or response opportunities, with no more than two sessions occurring per instructional day. During each respective, the participant, who was sitting on the floor of the play area, was given a simple “island puzzle” of no more than eight pieces and instructed to complete the puzzle. The puzzle had one-to-three missing pieces (depending on the total number of pieces), which was in the possession of the peer. The peer was positioned within three inches and in front of the participant. Additionally, the participants speech-generating device was positioned within three inches to the right or left of the participant.

Baseline During baseline, mands were contrived as described above. After the participant completed the puzzle with the exception of the missing pieces and the participant demonstrated prelinguistic communication by reaching for the missing puzzle piece, the experimenter began a five-second-time delay. If he or she did not reach for the missing piece, he or she was again told to complete the puzzle, while the peer held the puzzle piece in front of the participant, until he or she demonstrated prelinguistic communication in the form of reaching for the puzzle piece, at which point the experimenter began the five-second-time delay. If the participant independently manded for the missing puzzle piece using the iPad® based SGD or by using vocal speech, within the five-second-time delay, he or she was granted access to the item. Although vocal manding would have been accepted as a “yes” on the probe, no vocal mands ever occurred for any of the three participants. If after the five-second-time delay no mand occurred, the trial was considered as a *no response* (see dependent measures) and the trial was considered complete. Trials continued in this manner until data were collected for 10-trials, which comprised a complete session.

Training Sessions During training sessions peer mands were contrived as described above. After the five-second-time delay had passed and no mand occurred, a full-physical prompt was used to evoke correct responding and a trial was considered complete. If the participant manded for the puzzle piece within the five-second time delay, the trial was considered independent, trials continued in this manner until data were collected for 10-trials, which comprised a complete session.

Maintenance Maintenance sessions were conducted immediately after acquisition was obtained and the procedures were identical to baseline. No prompting occurred during maintenance trials. Due to time constraints, follow-up data collection was not possible and is a limitation of the research design.

Results

The results for all three participants are depicted in Fig. 1. Baseline data for Sally were stable, as she demonstrated no instances of independent manding prior to the introduction of training. Linda and Nate both demonstrated relatively stable data for baseline,

each only demonstrating a few instances of independent manding during the baseline phase. All three participants acquired independent manding with relative immediacy, requiring an average of 4.3 sessions to reach mastery criterion. The collection of maintenance data for Sally indicates that the skill maintained. For Linda and Nate, practical time constraints only allowed for one session of maintenance data to be collected for Linda and two sessions of maintenance data collected for Nate. However, those sessions indicated maintenance of the training occurred.

Sally

As depicted in Fig. 1, Sally never independently manded during three sessions of baseline, with an average percentage of responding at 0%. After four sessions of training, Sally met mastery criteria for manding. She averaged 80% independent responding during training. Sally maintained independent manding with an average 96% of mands being independent over four maintenance sessions.

In terms of visual analysis, an immediate therapeutic change in responding is evident following the introduction of the intervention during session four. A clear increasing trend during training, with stabilization during maintenance, is also apparent. In regard to effect size, the calculation of the percentage of non-overlapping data indicates the treatment is highly effective, with 100% non-overlapping data across baseline, treatment, and maintenance.

Linda

During baseline Linda demonstrated independent manding in one session, in which she manded at 40% independence. Overall, Linda averaged 7% independent responding during baseline. After six sessions of training, Linda met mastery criteria by demonstrating at least 80% independent mands over three consecutive sessions. Average independent responding during training was 67%. Due to time constraints, only one maintenance session was performed, where she demonstrated 80% independent mands.

In terms of visual analysis, an immediate change is evident from session six to the first training session, in session seven. Although, there is a slight decrease in the trend during session nine, a clear therapeutic trend is apparent during training, with stabilization occurring across sessions 10 through 13. In regard to effect size, the calculation of the percentage of non-overlapping data indicates the treatment is moderately effective, with 84% non-overlapping data across baseline, treatment, and maintenance.

Nate

Nate demonstrated independent manding in three sessions of the twelve sessions of baseline, during which he averaged 12% independent responding. He achieved mastery criteria following three sessions of training, in which he averaged 100% independent responding. Due to time constraints, only two maintenance sessions were completed for Nate, during which he averaged 90% independent responding.

In terms of visual analysis, an immediate therapeutic change in responding is evident following the introduction of the intervention during session 13. A high degree of magnitude in terms of effect and immediate stabilization during training is evident. In

regard to effect size, the calculation of the percentage of non-overlapping data indicates the treatment is highly effective, with 100% non-overlapping data across baseline, treatment, and maintenance.

Discussion

The purpose of this study was to extend the literature by evaluating the use of an interrupted chain procedure in the acquisition of peer manding, with three preschool aged children with autism. To do this, participants were presented with a puzzle that was missing pieces needed for completion, that were in the possess of a peer. When the participant manded using the SGD for the missing puzzle piece, that mand was reinforced by the peer listener. This study has two notable differences from literature on the topic of peer manding. First is the use of a speech-generating device (SGD) as the augmentative and alternative communication system (AAC). Second was the use of the interrupted chain procedure as the method for contriving peer mands.

The results of this investigation were positive and indicate that the use of an interrupted chain procedure, with a five-second time delay and full physical prompt, is effective in establishing peer manding in preschool aged children with autism, using a tablet-based SGD. Given what the literature has consistently demonstrated in terms of tablet-based SGD instructional strategies, these results should not be surprising. That is, given the use of evidenced based strategies such as the five-second time delay and reinforcement, we should expect such acquisition to occur.

What is surprising, is the rapid rate at which acquisition occurred. The participants required an average of four training sessions to reach the mastery criteria of 80% independent and accurate responding, across three consecutive sessions, with a range of three-to-six sessions. One participant only required three training sessions and another participant required four, despite very limited responding during baseline. Although the collection of three maintenance data points was a procedural limitation of the study (see below), those data that were collected indicate that maintenance was occurring and would have been likely to continue.

Though the results are not necessarily unexpected, they are important in terms of clinical usefulness. Impairment in social communication is a hallmark feature of a preschool aged child with autism, and this study helps advance our practices in terms of how to establish social communication not only for a child with autism, but also a child who relies on a SGD for communication purposes. In standard peer dyadic mand training, the reinforcer used for mand training requires careful consideration and is often either a toy or an edible item (i.e., a snack). Lorah et al. (2014) highlighted two potentially problematic factors with the use of such peer manding scenarios. First, is that with the use of a toy as a reinforcer, the EO (deprivation) tends to build slowly. Thus, it is often difficult to ensure that motivation is present when contriving a mand. Secondary to that is the peer listener's willingness to reinforce the mand within that scenario. Meaning, the peer must be willing to hand over the toy. A second potential limitation relates to the use of edible reinforcers for mand training. When using a snack item, it is often difficult to ensure that food will function as a reinforcer (that the EO or deprivation is present), and the withholding of food to manipulate the EO may present ethical implications.

Despite the fact that this study had both positive results and presents an important alternative to the establishment of peer manding for preschool aged children with autism, it is not without limitations. First, data were not collected on the peer mentor training. Although we have literature on how to train parents as interventionists in Applied Behavior Analysis, there is less literature on peer confederate training. This study could have advanced the field in that way; but unfortunately, this aspect was not included in the research design. Future investigations may seek to advance the literature in this way.

A secondary limitation is the lack of a social validity component to the research design. This would have been especially interesting in terms of the peers' impressions of the training and the participants' acquired ability to mand for an item needed to complete a task related activity. The lack of three data points for maintenance across all three participants is also a limitation that forces the conclusions of the study. Ideally three data points for each participant should have been collected. Finally, the lack of a generalization phase does not allow for an analysis of whether generalization would have occurred. That said, time constraints are a practical consideration in applied research, and one that is not easily overcome.

Despite these limitations, this study adds support to the use of the interrupted chain procedure for the establishment of both mands and peer manding in young children with autism. It also adds support to the use of SGD more generally for the establishment of manding in young children with autism. Finally, it provides further evidence as to the effectiveness of the time-delay with full physical prompting instructional strategy.

Compliance with Ethical Standards

Ethical Approval All procedures performed in studies involving human participants were in compliance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from the parents/guardians of the individual participants included in the study.

Conflict of Interest The authors declare that they have no conflict of interest.

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