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Evaluation of Using an Interrupted Behavior Chain Procedure to Teach Mands to Children with Autism

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Evaluation of the Generalization Effects of Using an Interrupted Behavior Chain

Procedure to Teach Mand to Children with Autism

by

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A thesis submitted in partial fulfillment
of the requirements for the degree of
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Abstract

Interrupted behavior chain procedures have been shown to be an effective way to teach individuals with intellectual disabilities and autism to mand for missing objects and information concerning missing objects. Research has shown that an interrupted behavior chain procedure is more effective than traditional mand teach trials, which occur at the onset of a behavior chain or in a massed trial format. However, there is a lack of research evaluating the use of interrupted behavior chain procedures to teach vocal mands for missing items and the possible generalization effects thereof. This study evaluated the acquisition of vocal mands for missing items using interrupted behavior chain procedures, as well as participants' generalization of learned mands to novel behavior chains when said chains were interrupted. Each participant exhibited some form of generalization to a novel chain suggesting that interrupted behavior chains may be an efficient means to teach mands to children with autism. However, the extent to which a mand generalized across topographically distinct chains was different for each participant, suggesting that an individual's verbal repertoire could be a factor influencing generalization.

Chapter One: Introduction

Autism is a pervasive developmental disorder which often inhibits individuals from qualitative reciprocal social interaction and communication (American Psychiatric Association, Diagnostic and Statistical Manual of Mental Disorders, 2000). Children diagnosed with this disorder exhibit minor to severe delays in language acquisition, and many fail to develop any type of functional speech (Buron & Wolfberg, 2008; Carr & Kologinsky, 1983). The current trend in non-behavioral therapies for children on the autism spectrum is to focus on improving receptive and expressive language skills (Sundberg & Michael, 2001). Receptive and expressive language skills refer to the verbal behavior of a listener and speaker respectively and are targeted to increase an individual's functional speech (Sundberg, 1990). Although this approach seems to account for both the behavior of the listener and the speaker, it fails to offer an analysis of the variables related to response forms (Hall & Sundberg, 1987). In other words, this analysis fails when one asks the following questions: When, why, and to whom does the speaker speak, and how does a listener's response affect a speaker's behavior? Non-behavioral accounts of language acquisition are structural, focusing only on increasing topographies of responses. This oversimplification of a verbal event can lead to much frustration and failure for the child who is acquiring new communicative repertoires (Sundberg & Michael, 2001).

Instead of defining verbal behavior in terms of receptive and expressive communicative skills, B. F. Skinner (1957) defined verbal behavior as “behavior reinforced through the mediation of other persons” (p. 2). Therefore, one’s verbal behavior is reinforced by the behavior of an audience (i.e. another person) who also serves as a discriminative stimulus for responding. Skinner further divided verbal behavior into a taxonomy of six elementary classes or verbal operants, which are categorized by motivating variables, discriminative stimuli, and consequences. Unlike a traditional analysis of language, which treats words as stimuli with constant properties or inherent meanings, Skinner recognized that although a single word has the same topography across verbal operants, it is functionally distinct and related to the variables that evoke a response. This means that learning a word as a response form under one operant would not guarantee that an individual could then emit the same response form as another verbal operant. For example, a speech therapist may teach a child to label a picture of cookies. Although the child can reliably label the picture when asked “What is it?” he should not be assumed to be able to then *ask* for cookies when in a state of deprivation for cookies. Labeling an item and asking for an item are controlled by different environmental variables and are maintained by different consequences, even though the response topography (i.e., “cookies”) is the same. Although Skinner recognized that most typically developing individuals can transfer across operants, many individuals diagnosed with developmental disabilities and autism cannot make this transfer. Thus, understanding the variables that affect each operant is of utmost importance for the success of any language training program (Sundberg & Michael, 2001). This is especially made evident in training programs that use ineffective

consequences that do not evoke the desired response. Often, a failure to learn verbal behavior is blamed on the individual's disability and not ineffective teaching (Sundberg, 1990; Sundberg & Michael, 2001).

Mand training is one of the most useful teaching strategies often overlooked in language acquisition programs (Hall & Sundberg, 1987; Sundberg, 1990). Skinner (1957) defines the mand as "a verbal operant in which the response is reinforced by a characteristic consequence and is therefore under the control of relevant conditions of deprivation or aversive stimulation" (pp.35-36). In other words, a mand is a request for an item, activity, or for information in which the individual is in a state of deprivation. A mand can also be a request for aversive stimulation to cease. In the previous example, asking for cookies would qualify as a mand for cookies. Of the six elementary verbal operants, only the mand directly benefits the speaker by either allowing access to or escape from stimuli (Skinner, 1957). The other verbal operants are maintained by generalized conditioned reinforcement, which must be paired with other reinforcers before it is effective. The mand, however, has highly effective consequences because it is reinforced through the addition or withdrawal of a stimulus that is specified by the speaker, thus controlling the distribution of reinforcement. As such, the mand should be an early focus in any language training program. However, training programs have not always utilized mand training (Sundberg & Michael, 2001).

In addition to allowing the speaker control over the delivery of reinforcement, a manding repertoire is normally associated with a reduction in problematic behaviors which may have originally served a manding purpose (Carr, et al., 2002; Carr & Durand, 1985; Kahng, Hendrickson, & Vu, 2000; Sundberg, 1990; Sundberg & Michael, 2001;;

Winborn-Kemmerer, Ringdahl, Wacker, & Kitsukawa, 2009). Sundberg and Michael (2001) also report that mand training has high social validity, with parents frequently reporting that mand training is enjoyable and that their children often show a preference for the activity.

During mand training, the mand is often taught as an impure mand, meaning the child asks for the reinforcing item when the item is present (Sundberg & Michael, 2001). However, for the child to fully benefit from a manding repertoire, he or she should learn to mand for items when they are not physically present (Sundberg & Michael, 2001). For instance, if a child is in need of water, but there is no water physically present, he or she may engage in generalized manding behavior, such as pulling an adult towards a room where water is available. The adult must then determine what the child wants. Many children with autism lack a pure mand repertoire (manding for items in presence of EO but not S^D), which prevents them from communicating efficiently and effectively (Sundberg & Michael, 2001). Unfortunately, pure manding is not as extensively taught in verbal therapies because the teach trial must occur in the presence of an establishing operation (Sundberg & Michael, 2001).

Skinner (1957) identified a mand as being controlled by “relevant conditions of deprivation or aversive stimulation” (p. 35). Michael (1982) referred to these conditions as establishing operations. Establishing operations have two behavioral properties: (1) they momentarily alter the reinforcing effectiveness of an event, and (2) they momentarily alter the frequency of responses that have been characteristically reinforced by the event (Michael, 1982). The effects of establishing operations differ from operant and respondent conditioning because establishing operations are functions of time and

only last as long as the proper environmental variables are present. In other words, establishing operations differ from discriminative stimuli because they do not signal the availability of reinforcement, but rather make a specific stimulus more salient and increase the likelihood that an individual will emit a response form that was previously reinforced with that stimulus (Cooper, Heron, & Heward, 2007).

Michael (1988) further divides establishing operations into unconditioned establishing operations (UEOs) and conditioned establishing operations (CEOs). UEOs refer to states of deprivation and aversive stimulation in which the reinforcer-establishing effects are unlearned, such as water and food deprivation and painful stimulation from changes in temperature. CEOs refer to establishing operations whose reinforcer-establishing effects are learned. These CEOs (1) momentarily alter the reinforcing effectiveness of an event, and (2) momentarily alter the frequency of responses that have been characteristically reinforced by the event; however, this is due to the individual's history of learning. Michael (1993) identified three types of CEOs: surrogate CEOs, reflexive CEOs, and transitive CEOs. Transitive CEOs have also been referred to as blocked-response CEOs (Michael, 1988) because the establishing operation is only strong as a function of the participant's EO for the final product or completion of a behavior chain. For example, an individual may mand for milk (UEO) when in a state of deprivation for the fluid. However, the context changes when an individual mands for milk when he or she needs milk to make chocolate milk. In the latter example, the EO for milk is only strong as a function of the participant's EO for the final product or completion of the behavior chain (e.g., chocolate milk). Michael (1993) refers to this CEO as transitive because the stimulus undergoes a change of function relative to the

stimuli present and the EO for the final product in the behavior chain. Although differentiating among CEOs may seem irrelevant, a practitioner's knowledge of transitive CEOs can greatly improve verbal behavior training because the stimuli used in an interrupted behavior chain undergo a change of function, which facilitates the stimuli to be used as appropriate manding targets where otherwise they would have no function for the individual who is developing a manding repertoire.

Hall and Sundberg (1987) first researched the use of transitive CEOs to teach mands to two deaf adolescents. Each adolescent was successfully taught to use sign language to mand for missing items within four interrupted behavior chains. In an interrupted behavior chain, one item is withheld from the individual, preventing him or her from completing an established sequence of behaviors already in his or her repertoire (i.e., the behavior chain). The individual must then mand for the missing item. An interrupted behavior chain differs from other formats of instruction because the trial is inserted in a sequence of behaviors, preventing the individual from completing the chain, which usually results in a reinforcer. Thus, the interrupted behavior chain procedure may partly be effective due to a negatively reinforcing function of asking for the missing item (Hunt, Goetz, Alwell, & Sailor, 1986). Goetz, Gee, and Sailor (1985) and Hunt et al. (1986) found interrupted behavior chain procedures to be more effective at teaching mands than traditional instruction, which usually occurs at the onset of the behavior chain or in mass trials. Interrupted behavior chain procedures have been used to teach mands of various response forms, including sign language, pictorial communication systems, and vocal verbal behavior (Alwell, Hunt, Goetz, & Sailor, 1989; Goetz et al., 1985; Hall &

Sundberg, 1997; Hunt et al., 1986; Lechago, Carr, Grow, Love, & Almason, 2010; Petursdottir, Carr, & Michael, 2005).

As described earlier, Hall and Sundberg (1987) taught two deaf participants to use sign language to mand for missing items using both tact and imitative transfer-of-stimulus-control procedures. In a tact transfer-of-stimulus-control procedure, the absence of a correct manding response initiates a tacting trial in which the participant is required to tact the item. After the participant has correctly tacted the item, the researcher initiates an impure mand trial by asking “What do you want?” with the characteristic item still present. After the participant correctly mands for the item, the item is removed and the behavior chain is reintroduced to allow the participant to emit a pure mand for the item. The process is the same with an imitative transfer-of-stimulus-control procedure, except the absence of correct manding is followed by an imitative sign trial. Results showed that both procedures were equally effective at teaching mands within interrupted behavior chains.

Goetz et al. (1985) extended the literature on interrupted behavior chains by teaching mands in an interrupted behavior chain to two individuals with severe intellectual disabilities. Participants were initially taught to mand for two items within traditional instructional trials (i.e., trial at the beginning of the behavior chain) by pointing to a picture of the appropriate item either from an array of three or fifteen pictures (depending on the participant’s repertoire). However, correct responding remained low for both participants during traditional instructional trials. Researchers then implemented an interrupted behavior chain procedure to teach the mands previously targeted in the traditional procedure. Once each participant was exposed to the

interrupted behavior chain procedure, his correct manding increased very quickly, with both participants learning to consistently mand for two target items.

Alwell et al. (1989), Goetz et al. (1985), and Hunt et al. (1986) investigated the use of pictorial communication systems as mand response forms within interrupted behavior chains. In these studies, the target mand item was often present in some way. In Goetz et al. and Hunt et al. the target item was present, and the participants were blocked from reaching the item until correctly manding for it. In addition, mands were also always verbally prompted with the experimenter asking “What do you want?” In Alwell et al. the target mand item was removed on some trials but was placed just out of the participant’s reach or held down so the participants could not retrieve them on other trials. Thus, although the participants acquired the target mands during these studies, the acquired mands should be assumed to have been multiply controlled by tactual responding as well as a state of deprivation occasioned by the interrupted behavior chain.

Hunt et al. (1986) and Alwell et al. (1989) also evaluated the generalization effects of teaching mands within interrupted behavior chains. Hunt et al. found that two of three participants generalized the mand response form of pointing to appropriate communicative pictures to mand for novel items within novel behavior chains. Alwell et al. further demonstrated generalization of the same mand response form across two novel settings for all three of their participants.

Lechago et al. (2010) successfully used echoic prompting within interrupted behavior chain procedures to teach three children on the autism spectrum to vocally mand for information about items missing within behavior chains. For instance, participants were taught to mand “Where is spoon?” for a spoon that was missing in a behavior chain

to make chocolate milk. Each response topography (e.g., “Where is spoon?”) was taught in the context of one behavior chain (e.g., a chain to create chocolate milk) and was then tested for generalization within two novel behavior chains (e.g., a chain to make a model volcano and a chain to set a table). All three participants generalized the response form to the additional behavior chains without additional training. In addition, a fourth chain was added in which a novel item (e.g., a puzzle piece was withheld from a novel behavior chain (e.g., a puzzle completion chain). Two of three participants generalized mands for information across response topographies and mand for a novel item within a novel behavior chain (i.e., asked “Where puzzle piece?” without training).

Although interrupted behavior chain procedures have been shown to be successful at teaching signed mands, stimulus selection-based mands, and vocal mands for information with generalizable results, there are no known studies evaluating the use of interrupted behavior chain procedures to teach vocal mands for missing items and the possible generalization effects thereof. Therefore, the current study a) evaluated the acquisition of vocal mands for missing items using interrupted behavior chain procedures, and b) evaluated participants’ generalization of learned mands to novel behavior chains when said chains were interrupted. Generalization was further evaluated to see if a) generalization occurred after one or multiple exemplar trainings, and b) if generalization was robust enough to occur in a dissimilar novel behavior chain.

Chapter Two: Method

Participants

Three participants previously diagnosed with autism and currently receiving verbal behavior therapy participated in the study. Each participant had a well-developed echoic repertoire, followed one-step directions, and had at least a developing mand repertoire. Participants' verbal repertoires were assessed with the Assessment of Basic Language and Learning Skills (ABLLS-R). The ABLLS-R is a criterion referenced assessment and skills tracking system that assesses the language and daily living skills of children on the autism spectrum who function at or below a level characteristic of a typically developing 5 year-old (Partington, 2010). As an application of Skinner's analysis of verbal behavior, the ABLLS-R focuses on the functional independence of verbal operants, as well as those establishing operations that affect learner motivation (Partington, 2010). The ABLLS-R is preferred over standardized tests because it examines each verbal operant individually, which effectively guides program decision making by identifying those variables that need to be manipulated for acquisition of new verbal repertoires. The ABLLS-R assessment was completed by a board certified behavior analyst with experience in teaching verbal behavior to children with autism. Specific information regarding participant tact and mand repertoires was gathered from data collected by each participant's behavior therapist. These data were not further verified by the researcher. Ryan was a 5-year old Caucasian male who was diagnosed

with autism. He attended a local elementary ESE classroom and only received verbal behavior therapy services. At the beginning of the study, Ryan was only documented to mand for five different present items (multiply controlled). Ryan was never documented to mand for items that were missing in his environment, except for “candy,” which he frequently emitted during sessions. Ryan was recorded to have 12 tacts in his repertoire.

Ben was an African-American male who at the beginning of the study was 4 and turned 5 soon before the study ended. According to a neurological evaluation, he had dyspraxia in regards to his speech and fine motor skills, with a developmental speech disorder. He was diagnosed with autism at the age of three. Ben attended a local public preschool where he was fully mainstreamed in a typical classroom. At the beginning of the study, Ben had a well-developed manding repertoire with a documented 130 mands for present items (multiply controlled), 26 mands for missing items (not multiply controlled), and 106 mands for activities and/or social interactions. Ben also had a well-developed tact repertoire and was able to tact over 100 items as well as common colors and shapes and formal properties of size (big and little).

Jack was a 6-year old Caucasian male diagnosed with autism. He attended a local mainstreamed preschool where he also received occupational and speech therapies. At the beginning of the study, it was documented that Jack could mand for over 100 present items (multiply controlled). During the course of the study, Jack’s behavior therapists began teaching him to mand for items that were missing in his environment (not multiply controlled); however, the target mand “pumpkin seeds” was never targeted as a mand. Jack could also tact over 100 items as well as common colors, shapes, and formal properties of size (big and little).

Setting and Materials

All training sessions took place at a local clinic that provides verbal behavior therapy for children with autism. Training sessions took place in one of three rooms: a 3m by 2.5m kitchen, a 9m by 18m kitchen or a 5m by 4m therapy room depending on the day of the week and the participant receiving intervention that day. Each kitchen was furnished with a small table and chairs for the participant and researcher, a larger table for holding different materials, a trashcan, a refrigerator, and the necessary materials needed for each behavior chain. The therapy room was divided into 1.5m by 1.5m cubicles, and each cubicle was furnished with a table, chairs for the participant and researcher, and the necessary materials needed during individual chaining procedures. A video camera was also present across settings to record sessions for data collection purposes.

Target Behaviors

Data were collected on each participant's completion of designated behavior chains. Each behavior chain had an associated task analysis, which was used in data collection (see Table 1). A correct response was scored once the participant did the following: 1) independently began the next step in the behavior chain within 10 s of ending the prior step or immediately upon presentation of the stimuli if it was the first step in the behavior chain, and 2) executed the step correctly. Thus, if the participant independently began step eight within 10 s of completing step seven, and completed step eight in such a way that step nine was able to be performed, then step eight would have been scored as a yes.

Probe data were collected on the acquisition of trained mands as well as on mands that generalized across behavior chains. Mands consisted of the participant using one word to request an object that was missing (e.g., “spoon”) from his environment. Correct responding for both trained and generalized mands was an independent response of the appropriate topography emitted within 10 s of completing the step immediately prior to the step in which the mand was necessary. In other words, for the chocolate milk chain the participant manded “spoon” during the step in which the spoon was needed without any prompts from the researcher. Incorrect responses were responses that were not of the appropriate topography (i.e. “straw” when the target item was a spoon) or were responses that occurred after 10 s when the researcher had begun to prompt or has finished prompting the correct topography (i.e., “spoon”). For Ryan the target mand was “spoon.” Both Ben and Jack’s target mand was pumpkin seeds (see Table 1). Generalized mands were of the same topography as taught mands; however, these mands were probed within novel behavior chains. Ryan’s target chain was making chocolate milk, and his first generalization chain was making strawberry milk (see Table 1). These two chains were topographically very similar, with the same stimuli being used for both chains. The only difference between the chains was the chocolate powder and strawberry syrup respectively. Ryan’s second generalization chain was setting a table (see Table 1). This chain was topographically very different from the previous two chains. The only common item was the supply box that was used for the stimuli and the spoon that was withheld during trials. Ben’s target chain was making a pumpkin, and his first generalization chain was making trail mix (see Table 1). Topographically these chains were dissimilar. Common stimuli included the supply box in which stimuli were stored and the pumpkin

seeds that were withheld during trials. Ben's second probe for generalization was making maracas (see Table 1). This chain was also dissimilar to the previous two chains. The only common stimuli were the supply box in which stimuli were held, an empty cup for dumping the pumpkin seeds, and the pumpkin seeds that were withheld during trials. Jack's target chain was making trail mix, and his first generalization probe chain was making maracas. Jack's second generalization probe chain was the modified pumpkin chain (see Table 1). Common stimuli consisted of the supply box used to store stimuli and the pumpkin seeds withheld during trials.

Data Collection

Data were collected on each participant's completion of complete two behavior chains. These data were scored using a task analysis (see Table 1). Each component of the task analysis was scored as either a yes or a no depending on the presence or absence of the target response. After the participant mastered the behavior chains (two consecutive sessions at 90% accuracy with the first probe being correct), baseline data were taken. During baseline, data were collected on each participant's mand for an item that was needed to complete a chain of behaviors. Participant responses were scored as either a yes or a no depending on the presence or absence of the target response (e.g., "spoon"). Data on trained mands and mands that generalized were both collected and scored as either a yes or a no depending on the presence or absence of a correct response.

Observer Agreement and Treatment Integrity

Data were collected by the researcher, and interobserver agreement (IOA) was collected by independent observers who viewed recordings of 69% of sessions. Two graduate and one undergraduate research assistants were recruited from an applied

behavior analysis program at a local university to act as secondary observers. Observers reviewed recordings of each session and determined IOA by dividing the trials with agreements (trials during which both observers scored either a yes or no) by the sum of trials with agreements and disagreements and by multiplying this quotient by 100. An agreement was defined as both observers recording the same response (i.e., both yes or both no). Agreement was assessed for 83% of Ryan's sessions and was 98%. Agreement was assessed for 65% of Ben's sessions and was 99.2%. Agreement was assessed for 50% of Jack's sessions and was 100%. Data on the implementation of all procedures (behavior chain and mand training, error correction, and generalization probes) were collected using a treatment integrity checklist, which the same independent observers scored from recordings of 50% of sessions. Treatment integrity was assessed across each phase and was 99%.

Experimental Design

A nonconcurrent multiple baseline across participants design was used to show the acquisition of mands across participants, and data were recorded in two different behavior chains to assess the generalization of mands across behavior chains. After the participant had mastered all of the steps in the target behavior chain and all the steps in the first generalization behavior chain (90% accuracy across two consecutive days, with the first probe being correct), the researcher took baseline data to probe for the presence or absence of the target mand. After conducting baseline, the researcher then taught the target mand within the context of the target behavior chain while also probing for generalization of the same mand within the generalization behavior chain (see Table 1). For example, the researcher taught the mand for spoon using an interrupted behavior

chain for making chocolate milk. As the participant (Ryan) acquired the mand for spoon, the researcher interspersed generalization trials (five per session) in which another behavior chain also required but was missing a spoon (strawberry milk chain). A manding target was considered mastered once the participant manded with 90% accuracy across two consecutive sessions, with the first probe being correct. Mands within generalization probes had a similar mastery criterion with 100% correct responding across two days needed to show mastery.

Procedures

Participants were recruited at a local clinic that provides verbal behavior therapy for children diagnosed with autism. Each participant currently had some form of mand training within his therapy program; however, each participant's target mand was excluded from his therapy programming. Each participant received one to three sessions per training day at least twice per week. Sessions lasted for approximately an hour; however, there were always ten training trials and five generalization probes, unless training was not in effect.

Preference assessment. Each participant's parent was asked to identify highly preferred items to be used in a forced-choice preference assessment using procedures described by Fisher et al. (1992). Each stimulus was paired with every other stimulus in a randomized order until all stimuli had been paired. Preferred items were identified by dividing the number of times an item was selected by the number of times it was available and multiplying by 100. One of the items with the two highest selection percentages was delivered after the completion of each chaining procedure with the exception of Ryan who always manded for an item that was not used during his

preference assessment. (Ryan's mother informed the researcher that he greatly preferred chocolate candy, which was the only type of candy used during his preference assessment. During sessions, however, Ryan pointed to a cabinet containing Skittles and repeatedly said "candy.") During sessions, the researcher assessed current motivation for items by allowing the participant to select which item he would earn contingent on the completion of each behavior chain with the exception of Ryan who manded for the Skittles without any type of prompting.

Chaining. The researcher taught each participant to complete two behavior chains that shared one common item (e.g., both need a spoon for completion). One behavior chain was used to teach the mand for the missing item. The other behavior chain was used as a generalization probe (see Table 1). The items needed to complete each chain were stored in a supply box, which the participant accessed during trials. Each behavior chain was three to four steps and was taught using prompt shaping and fading. A total task presentation procedure was used for both Ben and Jack. During a total task presentation procedure, the entire behavior chain is taught as one unit, with the entire chain being completed at the conclusion of each trial (Miltenberger, 2008). For instance, a behavior chain involving five steps would be taught as a single unit, with each step completed in rapid sequence. Thus, a behavior chain for making chocolate milk involved the following: 1) take supplies out of the box; 2) take wrappers off the tops of two glasses containing milk and chocolate powder respectively; 3) pour the chocolate powder into the milk; and 4) use a spoon to stir chocolate powder in milk. After providing the S^D to engage in the task (e.g., "Make chocolate milk."), the researcher used graduated guidance to teach the behavior chain. More specifically, the

researcher took the participant's hands and guided him through the steps so that each step was completed by the participant and researcher at the same time (Cooper et al., 2007). Once the participant began to initiate individual steps in the chaining procedure, the researcher faded prompting and began shadowing the participant's hands by holding her hands directly above the participant's. As the participant continued to complete the chain with accuracy, the researcher faded prompting completely and removed her hands from the participant. Total task procedures were used with Ryan initially, but the researcher switched to backward chaining when Ryan was not making sufficient progress with the last two steps. In backward chaining, the researcher presented the last S^D (e.g., a cup containing chocolate powder resting on top of milk and not yet stirred), prompted the last behavior in the chain, and provided a reinforcer contingent on that behavior, given the chain did not result in a natural reinforcer (Miltenberger, 2008). The researcher faded prompts in the same way previously described. Chaining procedures were considered mastered once the participant had performed the entire chain unprompted with 90% accuracy across two consecutive days, with the first probe being correct.

Table 1: Behavior Chain Description

Behavior Chains	Chaining Steps	Function
Chocolate Milk Chain	<ol style="list-style-type: none"> 1. Take supplies out of the box (glass containing milk, chocolate milk powder, and spoon). 2. Take wrappers off the tops of a glass containing milk and a glass containing chocolate powder. 3. Pour chocolate milk powder in glass containing milk. 4. Use spoon to stir the powder in the milk. 	Target Chain for Ryan
Strawberry Milk Chain	<ol style="list-style-type: none"> 1. Take supplies out of the box (glass containing milk, strawberry milk container, and spoon). 2. Take wrappers off the tops of a glass containing milk and a glass containing strawberry milk syrup. 3. Pour strawberry milk syrup into glass containing milk. 4. Use spoon to stir the liquid in the milk. 	Generalization Chain 1 for Ryan
Table Setting Chain	<ol style="list-style-type: none"> 1. Take supplies out of the box (plate, spoon, knife, and fork). 2. Place plate on table. 3. Place fork on the left side of plate. 4. Place knife on right side of plate. 5. Place spoon on right side of knife. 	Generalization Chain 2 for Ryan
Pumpkin Chain	<ol style="list-style-type: none"> 1. Take supplies out of the box (ink pad, paper, pumpkin stamp, glue, and pumpkin seeds). 2. Take the lid of the ink pad. 3. Stamp the pumpkin stamp onto the paper. 4. Glue the pumpkin seeds onto the paper inside the pumpkin. 	Target Chain for Ben
Trail Mix Chain	<ol style="list-style-type: none"> 1. Take supplies out of box (glass jar, cup containing peanuts, cup containing raisins, and cup containing pumpkin seeds). 2. Pour the peanuts into the glass jar. 3. Pour the raisins into the glass jar. 4. Pour the pumpkin seeds into the glass jar. 	Generalization Chain 1 for Ben and Target Chain for Jack
Maraca Chain	<ol style="list-style-type: none"> 1. Take supplies out of box (paper plates stapled together on one side, orange crayon, stapler, and pumpkin seeds). 2. Pour the pumpkin seeds in between the paper plates. 3. Staple the paper plates together. 4. Color the top plate orange. 	Generalization Chain 2 for Ben and Generalization Chain 1 for Jack
Pumpkin Chain Modified	<ol style="list-style-type: none"> 1. Take supplies out of the box (paper containing pumpkin outline, glue, and closed container with pumpkin seeds). 2. Take the lid of the container with pumpkin seeds. 3. Glue the pumpkin seeds onto the paper inside the pumpkin. 	Generalization Chain 2 for Jack

**These chain descriptions refer to each participants training and generalization chains.*

Baseline. Once the participant reached mastery criterion for both chaining procedures (i.e., 90% accuracy across two consecutive sessions, with the first probe being correct), the researcher conducted interrupted chaining trials for both the target chain and the first generalization chain. During these trials, the target manding item was removed from the supply box. The researcher then recorded whether the participant correctly manded for the item within 10 s of the presentation of the appropriate S^D (i.e., the completion of the previous step). Once 10 s had passed without the participant correctly manding, the researcher handed the needed item to the participant so he could complete the chain. If the participant held out his hand or used an incorrect vocal topography to mand, the researcher still waited the full 10 s before handing the participant the item. After completing the chain, the researcher provided the participant with a preferred item based off the participant's preference assessment and stimulus selection during that session. Baseline data were collected to indicate that the participant did not have the target mand in his repertoire.

Training. Each session consisted of ten training trials and five generalization trials interspersed within training trials. Participants also watched a video that they had selected prior to the session in between trials with the exception of Ben who frequently manded to do more work. After completing baseline, the researcher continued to withhold the target manding item. Once the participant reached the step in the behavior chain in which the target item was needed, the researcher immediately prompted correct manding. For instance, the participant may have executed the following steps: 1) take supplies out of the box; 2) take wrapper off the top of a glass holding milk and a glass containing chocolate powder; and 3) pour chocolate powder in milk. However, once the

participant reached the fourth step (use a spoon to stir chocolate powder in milk), the researcher immediately said, “What do you need/want?” and then immediately supplied the correct response (e.g., “spoon”), which the participant repeated. A graduated time delay (Cooper et al., 2007) was used across trials within session to fade prompts. Initially, the researcher immediately prompted correct responding; however, after several trials, the researcher waited 2-3 s before prompting the correct response. Once the participant had begun to mand for the item, the researcher faded the prompt further and waited longer (4-6 s) before prompting the correct response. This process continued until the participant reached mastery criterion (90% accuracy across two consecutive sessions, with the initial probe being correct) for correct responding. Incorrect responses were immediately corrected with the researcher saying “spoon” and requiring the participant to repeat “spoon.”

Generalization. There were five probes for generalization interspersed within each session. Probes for generalization resembled baseline probes in that the target mand was not taught. For instance, during a session, if the participant was taught to mand for a spoon in a behavior chain for making chocolate milk (See Table 1), the researcher interspersed a generalization probe (strawberry milk) after running a few training trials (average of two trials). Generalization probes were never sequential.

Probes for generalization required the same response topography as the mand that was targeted for acquisition (e.g., “spoon,” “pumpkin seeds”). That is, the participant was required to emit the mand (e.g., “spoon,” “pumpkin seeds”) during a different behavior chain in which the mand had not been taught. After mastering the target mand, if the participant had not generalized the mand to the second behavior chain (i.e., had not

shown mastery) within two data points, the mand was taught for that chain. Thus, the generalization chain became a training chain for the target mand.

After the participant had either a) demonstrated generalization to a novel behavior chain, or b) had been trained on the first generalization chain, the researcher taught the participant to complete a new behavior chain using the procedures that were previously described. This behavior chain was topographically dissimilar to the previously learned behavior chains (see Table 1). After the participant demonstrated mastery on completing the chain (90% correct responding across two consecutive days with the first probe being correct), the researcher conducted a maximum of ten probes (across two days) to see if the participant generalized responding to a dissimilar behavior chain. If the participant showed generalization, he received his preferred item upon correct completion of each chain. If the participant did not demonstrate mastery, the manding target was not taught and the participant was dismissed from the study. The mastery criterion was the same as with other generalization targets (i.e., 100% correct responding across two days).

Chapter Three: Results

The results for each participant are depicted in Figure 1. As seen in Figure 1 none of the participants manded for the missing item during baseline (“spoon” for Ryan and “pumpkin seeds” for Jack and Ben). Ryan acquired the mand for spoon within the training chain (making chocolate milk) in 17 training sessions across 12 days. Ben acquired the mand for pumpkin seeds within the training chain (making a pumpkin) within four training sessions across four days. Ryan acquired the mand for pumpkin seeds within the training chain (making trail mix) within three training sessions across three days. Ryan generalized the mand for spoon to a novel chain (strawberry milk chain) within six sessions across six days. However, Ryan did not show generalization of the mand for spoon to a second novel, topographically dissimilar chain. Ben did not generalize the mand for pumpkin seeds to the generalization chain (making trail mix) and had to be taught to mand for pumpkin seeds within this chain. He mastered the mand for pumpkin seeds in this chain in three sessions across three days. Ben did generalize the mand for pumpkin seeds to the maraca generalization chain after being trained on two chains. Jack generalized the mand for pumpkin seeds to both generalization chains and did not need further training. He displayed mastery within the maraca chain and pumpkin chain (first and second generalization probe respectively) within two sessions across two days.

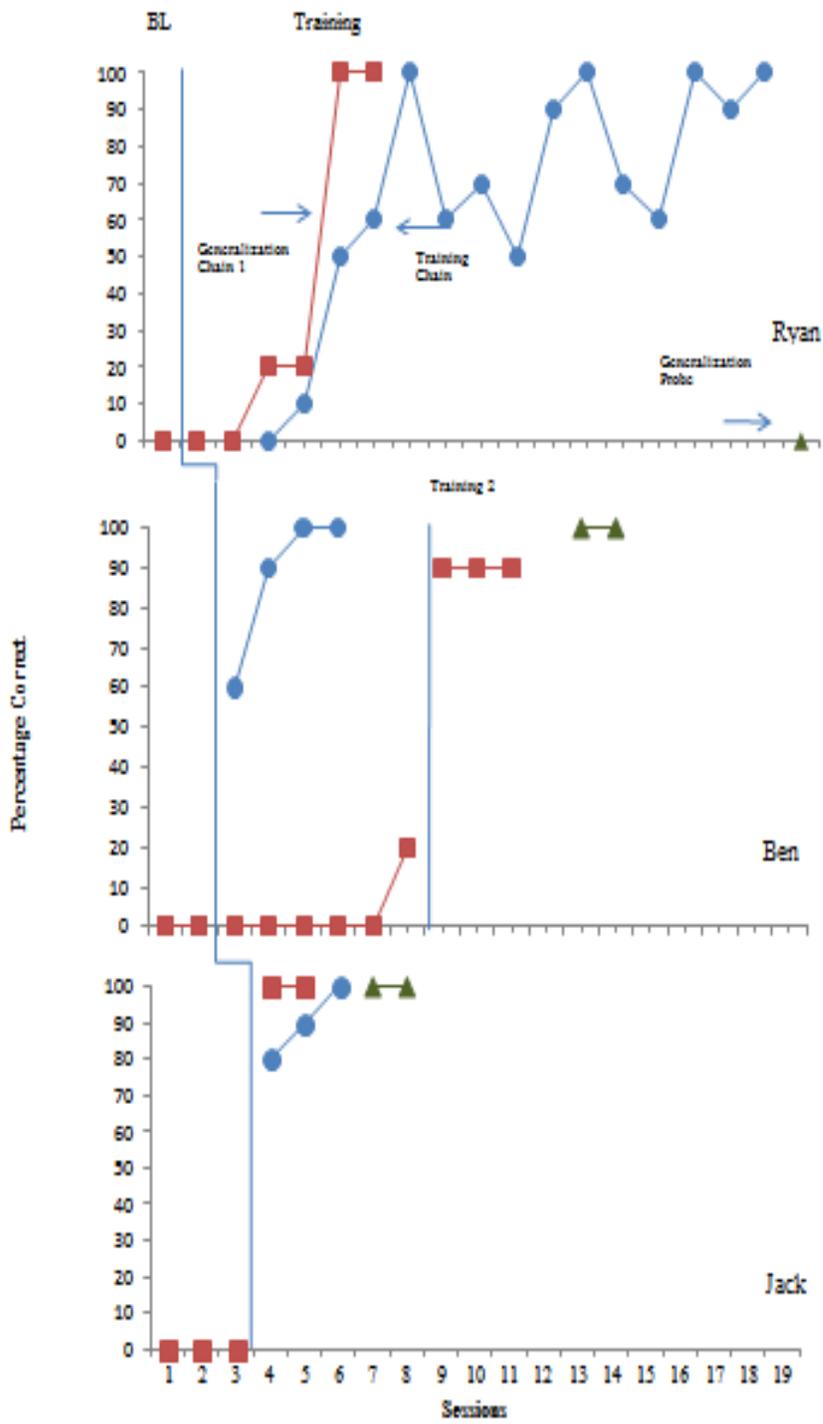


Figure 1. Participant Results. This figure shows the acquisition of trained and generalized mands across three participants.

Chapter Four: Discussion

The current study extends the literature on using interrupted behavior chains to teach mands to children with autism by demonstrating moderate generalization effects to novel behavior chains in which the previously trained mand would be appropriate. The targeted mand generalized to a novel behavior chain after being taught in one behavior chain for two of three participants. For one participant, the targeted mand generalized to a novel behavior chain after being taught in two exemplar behavior chains. Two of three participants also generalized the trained mand to a topographically dissimilar behavior chain, suggesting that the generalization effects of using an interrupted behavior chain procedure could be robust for some participants.

Additional analyses of the data also suggest that mand to tact transfers may have occurred for two of three participants who had extensive tacting repertoires (Ben and Jack). During baseline, the researcher used the S^D “What is it?” while holding up the target item (a spoon for Ryan and pumpkin seeds for Ben and Jack). The researcher ran ten such trials, interspersing trials in which participants were asked to complete an action previously recorded to be in their repertoire. None of the participants emitted an appropriate tact when presented with the S^D “What is it?” After training was completed, the researcher ran tact trials again in the format just described, and both Ben and Jack emitted 100% correct responding post-intervention without explicitly being taught to tact the target item (pumpkin seeds), suggesting a possible degree of functional

interdependence of the verbal operants in regards to the mand and tact. These findings are similar to what has been reported in the literature (Arntzen & Almås, 2002; Egan & Barnes-Holmes, 2009; Petursdottir et al., 2005). More research is needed to determine the conditions under which mand to tact transfers are facilitated, but the current study suggests that the participants' extensive tacting repertoire along with their familiarity with the verbal S^D "What is it?" perhaps helped facilitate a possible transfer.

Ryan displayed mastery of the mand for spoon within the generalization chain (making strawberry milk) before showing acquisition mastery in the training chain (making chocolate milk). These results may in part be attributed to different mastery criterion for the generalization chains (100% correct responding across two days), the topographical similarity of the training and generalization chain, the temporal proximity between the chaining probes and probes for generalization (often occurring within several minutes of each other), and the fact that the generalization chains were interspersed with the training chains. Perhaps interspersing generalization probes helped facilitate generalization. However, it appears that the two chains (chocolate milk and strawberry milk) were topographically similar enough that the interspersal of the two chains, along with the fact that the generalization chain was never probed first, perhaps prompted correct responding within the generalization chain. Future research should investigate the effects of interspersing probes for generalization during training. Although Ryan showed generalization of the mand for spoon from the chocolate milk chain to the strawberry milk chain, he did not show generalization of the mand for spoon to an additional generalization chain of setting the table (See Table 1). This may be partly due to the topographical dissimilarity of the two chains (chocolate milk chain and table setting

chain), which would indicate that the generalization effects for Ryan were not robust. It is interesting to note that Ryan had the least advanced vocal verbal repertoire of the three participants. He only manded for five reported items at the beginning of this study, and according to his therapists he often showed a lack of discrimination with these mands and often used incorrect response topographies. Future research should investigate the generalization effects of using an interrupted behavior chain to teach mands to participants who have a minimal manding repertoire.

Ben acquired the mand for pumpkin seeds within the training chain (making a pumpkin) within four sessions. However, he did not generalize the mand for pumpkin seeds to the generalization chain (making trail mix). It is interesting to note that the S^D for the training chain was “make a pumpkin,” and the S^D for the generalization chain was “make trail mix.” When trail mix chaining trials were interrupted, Ben consistently manded for “trail mix seeds” (29 out of 30 trials). He emitted the target mand (pumpkin seeds) one time only, which made his last data point before training 20%. Ben’s responding is interesting to note in light of Skinner’s (1957) analysis that “when two operants are of approximately the same strength at the same time, their responses seem to blend or fuse into a single new, and often apparently distorted form” (p. 293). Ben had a very strong tacting repertoire in addition to a strong manding repertoire. It is possible that the spatial and temporal context of the chains, along with the pairing of different S^D s (“Make a pumpkin”; “Make trail mix”) facilitated what Skinner referred to as “new combinations of fragmentary responses” (p.293) in which minimal units of responding are under the control of separate, yet equally strong variables that evoke a new, fragmented verbal response. Ben’s fragmented response appears to be an incorrect form

of response generalization (Cooper et al., 2007) that would be easily corrected in a less contrived situation, such as the social community. Once training in the trail mix chain was begun, Ben acquired the mand for pumpkin seeds within the trail mix chain in three sessions across three days. After acquiring the mand for pumpkin seeds in the trail mix chain, Ben showed generalization to the maraca chain (See Table 1).

Jack showed mastery of the mand for pumpkin seeds in the generalization probe (making maracas) before showing mastery for the acquisition of the mand for pumpkin seeds in the training probe (trail mix chain). These results are similar to Ryan's and may be attributed those factors previously discussed: the different mastery criterion for the generalization chains (100% correct responding across two days), the topographical similarity of the training and generalization chain, the temporal proximity between the chaining probes and probes for generalization (often occurring within several minutes of each other), and the fact that the generalization chains were interspersed with the training chains. Jack acquired the mand for pumpkin seeds within the training chain within four sessions. Unlike Ryan, Jack did show further generalization of the mand for pumpkin seeds in a second generalization chain (making a pumpkin, modified).

One limitation of the current study was that baseline was not carried out long enough for Ben to show experimental control across Ryan's and Ben's data. The researcher did not anticipate that Ben would learn the mand as quickly as he did, showing rapid increase in the accuracy of his responses in his first training session. Another possible limitation is that the topographical similarity of the behavior chains, along with interspersing generalization trials may have inflated generalization results. This appears to be the case for Ryan who did not emit the target mand in a second, topographically

dissimilar novel behavior chain. However, interspersing generalization trials may actually help promote generalization as was seen with Jack's results. Another limitation of the study is that the researcher never began a session with a generalization probe; thus, generalization probes always came after training probes. Future research should investigate if interspersing generalization trials with training trials provides any kind of benefit for generalization.

In conclusion the current research supports the literature on interrupted behavior chains by showing them to be effective at a) teaching mands and b) facilitating generalization of taught mands to novel behavior chains. More research is needed to determine the robustness of the generalization effects that can be expected from using an interrupted behavior chain, but this may be related to participants' verbal repertoires. Thus, further research is needed to determine which populations are best served through this intervention.

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Appendices

Appendix A: IRB Approval

eIRB: Study Approved Inbox x  

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to me ▾

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RE: Interrupted Behavior Chain Procedure
PI: [Blair Jacobsen](#)
Link: [Pro00007600](#)

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