AN EVALUATION OF A LAG SCHEDULE OF REINFORCEMENT AND PROGRESSIVE TIME DELAY ON VOCAL MAND VARIABILITY

A Thesis
Submitted to
the Temple University Graduate Board

In Partial Fulfillment
of the Requirements for the Degree
MASTER OF SCIENCE IN EDUCATION

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December 2019

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ABSTRACT

Individuals with autism spectrum disorder (ASD) may mand repetitively for preferred items using the same mand topography, unless the environment is arranged to promote mand variability. For example, an individual with ASD may request access to songs played on the radio by repeating the word “dance” only. Previous research suggests that lag schedules of reinforcement can increase variability of vocal mands displayed by individuals with ASD. The current study evaluated the effects of a lag schedule of reinforcement and progressive time delay (TD) on the vocal mands by a 27-year old male, 28-year old female, and a 26-year old female. The evaluation included a multiple baseline across behaviors with embedded reversal design. A mand topography invariance assessment (MTIA) was conducted with each participant to identify new and existing vocal mand topographies. Two conditions were used to assess variable responding when variability was (Lag 1 + TD) and was not (Lag 0) required to produce reinforcement. During Lag 0, reinforcement was contingent on instances of independent manding (of any topography). During Lag 1 +TD, reinforcement was contingent on instances of independent variant and prompted variant responses (i.e., a mand topography had to be different from the mand topography that occurred independently in the preceding trial). A progressive TD was used to transfer stimulus control from an echoic prompt to naturally occurring contingencies. Results indicated that a Lag 1 schedule of reinforcement with progressive TD resulted in acquisition of novel vocal mand topographies for all participants, with varying effects on rates of independent variant mands.

DEDICATION

This paper is dedicated to my parents, my sister, and Eric, all of whom provided me the strength I needed through this journey. Thank you to my parents for your encouragement and love from the beginning. To my sister, Jessica, I am forever grateful for your sound advice. You are my inspiration in this field of work, and beyond. To Eric, thank you for your unwavering support through the highs, lows, and everything in-between.

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CHAPTER 1

INTRODUCTION

Autism Spectrum Disorder (ASD) is a developmental disability that presents in early childhood (American Psychiatric Association, 2013). ASD is characterized by an individual's deficit in social communication and interaction, as well as restricted and repetitive behaviors and interests (American Psychiatric Association, 2013). Restricted patterns of behavior displayed by individuals with ASD are conceptualized as invariant behavior (Rodriguez & Thompson, 2015). When behavior variability is unnecessary for reinforcement to occur in a particular environment, responding will likely become restricted, or invariant. Invariant behaviors displayed by individuals with autism include stereotypy, rigid schedule following, fixed routines, and limiting interests in items (Muething, Falcomata, Ferguson, Swinnea, & Shpall, 2018). Operant responding that tends to be less variable than normal can interfere with adaptive responding of individuals with autism (Mullins & Rincover, 1985). An example of interfered adaptive responding is when stereotypy is disrupted and results in aggression (White et al., 2011). In another example, when many individuals with autism are taught to mand for preferred items, they learn to do so with the same tone of voice or words. Invariant behavior may limit the ability to communicate wants and needs, as well as decrease valuable social opportunities for individuals with ASD. Invariant responding can result in a loss of reinforcement when a predictable response is placed on extinction (Miller & Neuringer, 2000). Extinction includes the discontinuation of reinforcement for a previously reinforced behavior, which in turn results in a decrease in the frequency of the behavior

(Cooper, Heron, & Heward, 2007). An example of this would be if an individual with ASD uses the word "dance" to mand for music being played as reinforcement provided by the listener. If the listener does not understand "dance," or begins to engage in dancing behavior, a loss of reinforcement may occur. In this context, teaching different ways to request for music can result in reinforcement when one response is placed on extinction. Variability is an operant dimension of behavior that can be reinforced to facilitate the acquisition of new and creative responses (Neuringer, 2002).

Evaluation of Variability as Operant Behavior

Reinforcement of operant variability has been assessed within the basic and applied literature using several procedures (e.g., lag schedules of reinforcement, extinction, percentile schedules of reinforcement). A lag schedule of reinforcement consists of a specific number of prior responses that must differ in some way in order for the current response to be reinforced (Lee, McComas & Jawor, 2002). For example, in a Lag 1 schedule, a response is reinforced if it differs from the immediately preceding response. That is, an individual with autism may receive reinforcement for saying "dance" if the immediately preceding response was "song" in a Lag 1 schedule. In a Lag 3 schedule, reinforcement is provided for the first response that differs from the previous three responses. In the above example, the individual may receive reinforcement for saying "dance" if the previous three responses were "song," "play" and "music." Results of basic research show that when variability in responding was explicitly reinforced, organisms successfully varied their sequences (Page & Neuringer, 1985). Lag schedules of reinforcement have been used in the applied literature to increase individuals' with ASD responses to social questions (Lee, McComas, & Jawor, 2002) and tacts (Heldt &

Schlinger, 2012). Further, procedures that include conditions of extinction have shown to increase variability in lever pressing by rats (Neuringer, Kornell & Olufs, 2001) and communicative gestures displayed by children with ASD (Duker & van Lent, 1991). Percentile schedules of reinforcement use parameters specified by the experimenter to determine reinforcement criteria for responses (Galbicka, 1994). For example, during a 25% percentile schedule, a determined response is reinforced if it is displayed less than 25% of previous specified responses. Within the traditional operant laboratory procedure, an organism (e.g., pigeon) may be taught to press blue, red, and green keys. The organism may receive reinforcement for pressing a blue key when pressing a blue key was observed less than 25% of all previous key-pressing responses. Percentile schedules of reinforcement have been used to increase sequence variability in pigeons (Machado, 1989), button pressing during a computer simulation (Miller & Neuringer, 2000) and task engagement in individuals with ASD (Athens, Vollmer, & St. Peter Pipkin, 2007).

Responding Variably During Delays to Reinforcement

When reinforcement is abundant, operant responding often becomes repetitive. However, when reinforcement is withheld, responding varies, and organisms must find new ways to contact reinforcement (Balsam, Deich, & Stokes, 1998). Schedules of reinforcement and variability contingencies have been manipulated in order to compare their effects (Grunow & Neuringer, 2002; Wagner & Neuringer, 2006). Delays of reinforcement – intervals between the last response in a trial and reinforcement – on operant variability have been examined in the basic literature (Grunow & Neuringer, 2002; Wagner & Neuringer, 2006; Odum, Ward, Barnes, & Burke, 2006).

Grunow and Neuringer (2002) demonstrated that when rats displayed low levels of behavior variability initially, key-light and lever pressing response sequences increased as reinforcement frequencies decreased. The opposite was found when initial variability was high, showing that variability decreased as reinforcement rates decreased. Wagner and Neuringer (2006) assed response variability displayed by rats and varied the timing to reinforcement delivery. The results showed that as the timing of reinforcement delivery decreased with a delay to reinforcement in place, response variability increased for the participants that showed low variability initially.

Odum, Ward, Barnes, and Burke (2006) evaluated the effects of delays to reinforcement on sequence variability and rate in a study conducted with pigeons. This procedure consisted of a multiple schedule of reinforcement, where two components (i.e., a vary component and a repeat component) alternated following every fifth food delivery. The "vary" component required pigeons to engage in pecking sequences that differed from a specified number of previous sequences. The "repeat" component required responding to match the previous pecking response in the sequence. Then, reinforcement delays of 5, 15, and 30 s were introduced within both components. Results showed that no systematic effect was observed when the delay was included in the "vary" component. Variability in responding increased in the "repeat" component with the inclusion of the delay to reinforcement. As the time delay increased in the "repeat" component, variability in the sequences increased substantially. That is, when participants responded with low levels of variability initially, a delay to reinforcement component increased variable responding. In other words, organisms will respond in different ways over time if responding in one way is ineffective.

Wagner and Neuringer (2006) examined the effects of reinforcement delays on the levels of variability in response sequences displayed by rats. Percentile schedules of reinforcement were used to train three groups of rats to respond at different levels of variability. One group was rewarded for high variability, a second for middle, and a third for low levels. Reinforcement was delivered when the relative frequency of the current trial was less than 20% of the previous 25 sequences for the high group, less than 50% for the middle group, and less than 75% for the low group. Then, a reinforcement delay (i.e., 0.5, 16, 2, 8, 32 s) was implemented. Results showed that when reinforcement was delayed, the high variability group displayed a significant decrease in sequence variability. A small but insignificant increase was observed within the middle group's variability when reinforcement was delayed. Lastly, levels of variability increased significantly in the low group when the reinforcement delay was introduced. Similarly to Odum et al. (2006), Wagner and Neuringer (2006) found that as the duration of delays increased, participants with low variability initially displayed a significant increase in response variability.

The results of basic studies suggest that reinforcement contingencies can specify particular levels of variability (Grunow & Neuringer, 2002; Wagner & Neuringer, 2006; Odum, Ward, Barnes, & Burke, 2006). That is, animals learn to vary their responses when high, intermediate, or low levels of variability are required to gain access to reinforcement. Usually, operant responses are weakened when delays are imposed between a response and a reinforcer. However, the basic literature demonstrates that the contingency between a delayed reinforcer and a response could impact levels of operant

variability. Generally, organisms generate and maintain levels of variability depending on how variable their responding is initially.

Variability in the Verbal Behavior of Individuals with Autism

The basic literature suggests that response variability may be adaptive under environmental conditions where changes occur rapidly, and different responses are required for reinforcement (Odum et al., 2006; Wagner & Neuringer, 2006). Organisms will vary responses when responding in one way becomes restrictive over time. The concept of invariant behavior may be useful for practitioners in teaching children with autism. Individuals with ASD display deficits in social communication and interaction (American Psychiatric Association, 2013) where invariant responding in social situations is often observed. When individuals with ASD greet others with the same tone of voice and words, talk about one topic, and engage in other repetitive behaviors, a decrease in valuable social opportunities may occur (Wolfe, Slocum, & Kunnavatana, 2014). These deficits not only limit an individual's ability to engage with others, but also can limit communication of wants and needs.

Given the impact of a deficit in expressive language development, procedures to teach various communication skills may include a verbal behavior approach as described by B.F. Skinner (Finkel & Williams, 2001; Ingvarsson & Hollobaugh, 2011; Skinner, 1957). In *Verbal Behavior*, Skinner (1957) proposes a theory of several verbal operants (i.e., mand, tact, intraverbal, echoic, textual) defined by their characteristic antecedents and consequences (Goldsmith, LeBlanc, & Sautter, 2007). Of primary interest in the current research are the echoic and the mand. The echoic is verbal behavior evoked by a verbal discriminative stimulus and maintained by generalized conditioned reinforcement

(e.g., praise). Echoics are characterized by one-to-one correspondence and formal similarity between the discriminative stimulus and the target response (Skinner, 1957). A speaker hearing "dog," then saying "dog," followed by the listener response "that's correct" is an example of echoic responding. Next, the mand is a verbal operant maintained by a specific reinforcer and is evoked by an establishing operation for that reinforcer (Skinner, 1957). An example might be the response "milk please." This response is likely to occur following a period in which the speaker has not had something to drink, and is likely to be reinforced by someone providing milk.

Mand Training

Individuals with ASD may mand repetitively during mand training unless the environment is arranged to promote mand variability (Betz, Higbee, Kelley, Sellers, & Pollard, 2011; Brodhead, Higbee, Gerenscer, & Akers, 2016). For example, a learner may be taught to mand for water by saying, "drink." If the listener reinforces "drink" continuously under control of the relevant establishing operation, the learner may mand repetitively for water by saying, "drink" only. If repetitive manding is considered a concern with invariant responding, an intervention may include targeting the contingency between reinforcement and the variant dimension of the mand (Silbaugh, Falcomata, & Ferguson, 2018). Invariant responding may be replaced by delivering a reinforcer contingent on variant responding. For example, functional communication training (FCT) is a procedure that replaces challenging response topographies with at least one socially acceptable response using differential reinforcement (Carr & Durand, 1985). Differential reinforcement is often used in practice to teach novel responses. In this context, differential reinforcement occurs when one response is reinforced under a specific set of

stimulus conditions, and all other members of a response class do not receive reinforcement. A function-based approach for an invariance problem in mand training may include replacing an invariant response with a variant response, and differentially reinforcing the target response contingent on variant responding. The newly trained variant response is considered functionally equivalent, maintaining the same reinforcing consequences as the invariant response.

Generalization of novel responses is a common goal among many mand-training procedures. Functionally equivalent responses are assessed within a functional response class and/or response class hierarchy (RCH). A response class includes behaviors that produce the same effects on the environment (Carr, 1988). Response-class members can be topographically similar, such as vocal requests (various words or phrases), or topographically dissimilar, such as pointing and exchanging pictures. The probability of each response in a class may not be equal (Baer, 1982). For example, if pointing and exchanging pictures are part of a response class, the probability that one may occur first is most likely different for each response. These responses may replace one another, creating a response class hierarchy (RCH). Several dimensions of reinforcement impact the likelihood of the emission of a specific member in a response class, including the following: rate of reinforcement (i.e., the frequency of reinforcer delivery per interval), immediacy of reinforcement (i.e., the time between the response and reinforcer delivery), and response effort (i.e., the effort required to obtain reinforcement) (Baer, 1982, Mace 1994). In order to assess new mands to teach, treatment will evaluate the dimensions and schedules of reinforcement that increase variability within the individual response class.

Repetitive manding occurs when variability is not required for reinforcement. When the contingencies change, and reinforcement is not delivered quickly or immediately for a single response, individuals may continue to respond with other members in the RCH. A time delay technique, where reinforcement is systematically delayed, is often implemented to teach spontaneous vocal responding (Halle, Marshall, & Spradlin 1979). In a time delay procedure to teach spontaneous manding, the trainer will present the target stimulus (e.g., candy) and prompt the appropriate vocal response (i.e., "Candy please"). Once the learner can respond consistently to the echoic prompt, the onset of the prompt is delayed for a few seconds. In a progressive time delay procedure, the delay between the target stimulus (candy) and the echoic prompt ("Candy please") is increased. A successful transfer of stimulus control to the target stimulus is achieved when the learner responds in the presence of the target stimulus, and before the prompt is delivered. That is, the learner says, "Candy please" when presented with candy, before the instructor delivers the echoic prompt.

Lag Schedules and Mand Variability

Learning to vary one's responses may be prescriptive in situations where change occurs often, and variation is necessary to contact reinforcement under conditions of extinction. For example, an individual may request for dinner by saying, "give me pasta" to a familiar peer. In some social contexts, such as at a restaurant, "give me pasta" may be placed on extinction, where "I'd like pasta, please" may be reinforced. Previous research has focused on the effects of lag schedules on mand variability (Adami, Falcomata, Muething, & Hoffman, 2017; Brodhead, Higbee, Gerenscer, & Akers, 2016; Silbaugh, Falcomata, & Ferguson, 2018).

Brodhead, Higbee, Gerenscer, and Akers (2016) examined the effects of a discrimination training procedure and script training on mand variability in children with autism. Participants were presented with three highly preferred edibles. Manding was reinforced continuously (i.e., after every occurrence of a mand) during baseline. During the intervention, participants were taught to vary their vocal mands in the presence of different colored placements under lag schedules of reinforcement within two alternating conditions. The results demonstrated that, compared to baseline, lag schedules increased the number of different mand frames displayed by participants under the stimulus control of the colored placemat.

Adami, Falcomata, Muething, and Hoffman (2017) compared the effects of Lag 0 and Lag 1 schedules of reinforcement during functional communication training (FCT) on mand variability and challenging behavior of two individuals with autism. Based on the results of a functional analysis, each participant received functional communication training. Challenging behavior was differentially reinforced on a continuous schedule of reinforcement during baseline. During the Lag 0 phase of intervention, participants were presented with three non-vocal mand modalities (i.e., a picture, a microswitch, and a tablet). All selections of a mand modality to request an item were reinforced. During the Lag 1 phase, a modality selection was reinforced if it differed from the modality selected in the previous trial within the session. Results suggested that challenging behavior occurred at zero levels during FCT with a Lag 1 schedule of reinforcement. Similarly to Brodhead et al. (2016), using lag schedules increased mand variability.

Silbaugh, Falcomata, and Ferguson (2018) contributed to the literature by assessing the effects of a Lag 1 schedule of reinforcement and progressive time delay

(TD) on topographical vocal mand variability in children with autism. A multiple baseline across behaviors with an embedded reversal design was implemented. The participants included two English-speaking children with ASD that displayed echoic responding, independent vocal mands (1- and 2- word utterances) and limited vocal variability under conditions of delayed reinforcement. The primary dependent variables included variant and invariant manding. The secondary dependent variables were cumulative different mand topographies and different mand topographies within session. During Lag 0, varying mand topographies was not required to produce reinforcement. The reinforcer was delivered continuously when independent manding occurred every time the EO was presented. During Lag 1 + TD, reinforcement was delivered for the first instance of a mand each session, and the reinforcer was then delivered on prompted and independent variant mand topographies. An echoic prompt for a variant mand was delivered if variant mand topography did not occur during specified time delays. Results demonstrated that with low initial rates of independent variant manding during Lag 0 for both participants, a Lag 1 schedule combined with TD increased variability across functionally equivalent vocal mand topographies for both participants.

Silbaugh et al. (2018) differed from Brodhead et al. (2016) in several ways. First, Brodhead et al. (2016) assessed lag schedules on variability in mand frames, with the presentation of multiple reinforcers. Alternatively, Silbaugh et al. (2018) evaluated the effects of lag schedules on functionally-equivalent topographical mand variability in the presence of one reinforcer. The approach by Silbaugh et al. (2018) is useful in contexts where a specific reinforcer may be available, but listeners fail to quickly reinforce the mand. Second, the intervention taught by Brodhead et al. (2016) used scripts to prompt

variant mand frames, and Silbaugh et al. (2018) used echoic prompts. Using echoic prompts is an alternative to training individuals without a textual repertoire (Silbaugh et al, 2018).

The Current Study

The concept of an invariance problem may be clinically relevant when topographically repetitive manding is a socially valid target in intervention (Silbaugh et al, 2018). If a listener doesn't understand a response, or the response is placed on extinction in various contexts or with various audiences, an individual may lose access to their wants and needs. Given the benefits of training multiple response exemplars, there is utility in programming for varied responding by embedding lag schedules during mand training. Additional research is necessary to provide practical information on using lag schedules to increase topographical vocal mand variability for adults with ASD using echoic prompting, prompt fading and differential reinforcement. Therefore, the purpose of the current study is to evaluate the effects of a Lag 1 schedule of reinforcement combined with a progressive time delay (TD) on vocal mand topographies in adults with ASD and later assessing response class structure across phases using procedures described by Silbaugh et al (2018).

CHAPTER 2

METHOD

Participants

Therapist. The therapist for all sessions was the student investigator with approximately one year of experience working with adults with developmental disabilities at the start of the study. The student investigator had previous experience working as a direct therapist in a clinic that serves children and adolescents with autism. The student investigator is currently enrolled in a master's program studying Applied Behavior Analysis. The student investigator is a white female, and was 25-years-old at the start of the study.

*Individuals***.** Participants were recruited through an email sent to the management team (i.e., ABA Specialists, Board Certified Behavior Analysts, and Program Managers). To be considered for the study, participants were required to be at least 21-years-old at the start of the study. All participants were required to have a documented diagnosis of autism using criteria stated in the Diagnostic and Statistical Manual of Mental Disorders; Fifth Edition (DSM-5; American Psychiatric Association, 2013) to confirm symptoms by a qualified professional (e.g., licensed psychiatrist). The presence of a comorbid diagnosis was not considered within the inclusion criteria for the study and did not exclude participation. The student investigator inquired of clinical team members about individuals that demonstrated generalized echoic responding, as well as independent vocal mands limited to 1- and 2-word utterances or short sentences. It was required that participants demonstrated limited vocal variability under conditions of delayed reinforcement. Additionally, history of success with echoic-to-mand stimulus transfer

procedures using prompt fading and differential reinforcement was preferred. History of challenging behavior was not a focus of the current study. The first four individuals that met inclusion criteria for this study in response to the researchers' inquiry were considered for this study. There was one individual that met criteria, but did not get selected for the study and consent was not received due to scheduling conflicts. This individual was told that they may still receive further training by a behavior analyst in the program by request.

The study focused on three target participants. The individual information is available in Table 1. James, a 27-year old male was previously diagnosed with ASD at an undetermined date. James also has a secondary diagnosis of expressive language disorder. The second participant, Darcy, was a 28-year old female diagnosed with ASD in 2015, with a secondary diagnosis of bipolar disorder, unspecified. Grace, the third participant, was a 26-year old female diagnosed with ASD in 2015. Informed consent was obtained for each participant in the study.

Name	James	Darcy	Grace
Age	27 years 2 months	28 years 4 months	26 years 6 months
Gender	Male	Female	Female
Race	White	White	White
Medical Diagnosis	Autism	Autism	Autism
Secondary Diagnosis	Expressive language disorder	Bipolar disorder, unspecified	N/A
Communication Mode	Vocal/Verbal	Vocal/Verbal	Vocal/Verbal

Table 1. Participant Demographics. All participants' names have been changed to protect their anonymity.

Setting

The research was conducted at a day habilitation program located in southern New Jersey. The day habilitation program serves approximately 150 adults with developmental disabilities. The site was selected due to the large potential subject pool and the student investigator was employed at the agency throughout the study.

All sessions were conducted in a designated session room within the program building. The session room had a window and contained a table with three chairs. The session room was approximately 10’ x 8’ and was carpeted. There was one door that was shut for all sessions, but unlocked. All participants had minimal experience in the session room prior to the study. Throughout all evaluation sessions, the therapist sat in a chair directly across the table from each participant. When present, trained observers sat in a chair 3 to 5 feet away.

Materials

For the mand topography invariance assessment (MTIA) described below, an array of five to ten leisure items and/or edibles were provided by the primary researcher and presented on the table. Items were selected beforehand based on staff or guardian interviews and clinical observations. A paper data sheet (Appendix A) and pen was used to collect data by the primary researcher for the MTIA for each participant. Two reinforcing items were selected for James (cheese puffs and cookies), Darcy (M&M’S® and chips), and Grace (pretzels and chocolate) based on the results of the MTIA. For the evaluation sessions, only the target item was present and in view for each session. The primary researcher wore gloves when delivering edible reinforcers on a napkin on the table for each evaluation session. If an observer was present for an evaluation session, a

clipboard, pen, and procedural fidelity data sheet was provided to the observer. A session log, pen, and clipboard were present in the room for the primary researcher to track completed sessions.

The investigator provided in-ear Bluetooth headphones for the purpose of communication between the therapist and data collectors without disrupting sessions, however, the headphones were not needed.

Each session in the study was recorded on the investigator's video camera. The video camera was present in the room on a tripod approximately 2 to 3 feet away from the table. Video footage was reviewed after every session to collect data. Video files were stored on an external hard drive for later analysis and locked in a secure location. The external hard drive was password protected and only the primary researcher has the password. Trained observers used a laptop computer issued by the agency for data collection purposes.

Dependent Variables

Data were collected on prompted and independent variant and independent invariant mands for a total of three data collection categories of mand topographies. The primary dependent variables were (a) variant and (b) invariant mands. An independent variant mand was defined as an independent vocal response topography that differs from the previous word or word combination that occurs independently (Silbaugh, Falcomata, & Ferguson, 2018). An independent invariant mand was considered an independent vocal response topography that does *not* differ from the last word or word combination that occurs independently. A prompted variant mand was defined as a vocal response topography that differs from the last word or word combination, and is immediately

preceded by an echoic prompt. The secondary dependent variables were (a) cumulative different mand topographies and (b) different mand topographies within session. The first vocal mand topography that occurs in a session was recorded to identify the first variant mand topography.

Because the procedure was novel and there is little prior research on lag schedules and manding, and the study aimed to assess the variant dimension of the mand, a consideration was made similar to Silbaugh et al (2018). Any vocal mand topography was eligible for reinforcement throughout all phases of the study. That is, the vocal mands did not need to be a word or word phrase typically used to request the reinforcer by typically developing individuals to be considered variant. For example, if a participant said, "party" for M&M'S®, the response still counted as variant. In the current study, a single word or combination of words was considered 'different' if it differed from at least one word that occurred in previous sessions or within the current session. The primary researcher chose to allow any variant mand frame to also be eligible for reinforcement due to more advanced expressive language abilities displayed by participants. If at least one word in a given trial differed from the previous mand in the previous trial, the response was also considered variant. For example, "pretzel, please" differed from "another pretzel, please," and was therefore reinforced as a variant mand.

Frequency data were collected using DataPal software on all dependent variables observed in the evaluation sessions. Independent and prompted instances of topographically variant manding, and independent instances of topographically invariant manding, were counted, converted to responses per minute, and graphed for visual

analysis. Frequency data for the mand topography invariance assessment (MTIA) was converted to percentage of trials selected.

Mand Topography Invariance Assessment

The purpose of the mand topography invariance assessment (MTIA) was to identify the existing mands and accompanying reinforcers for inclusion in the study (Silbaugh et al., 2018). Additionally, the MTIA was used to choose two new vocal mands topographies to prompt during the evaluation. The assessment consisted of a single session, approximately 30 minutes in duration with each participant. The primary researcher was the therapist in all MTIAs. An array of leisure items and edibles was selected based on clinical observation or by staff or guardian interview. The number of items for the MTIA was between five and 10 items for each participant. The MTIA was conducted using an FR 1 schedule where 30 s of access to preferred items and edibles was provided for independent vocal mands. The primary researcher provided verbal attention and interacted with the participants with the items throughout the assessment. An item was selected for inclusion in the study if (a) its removal was shown too quickly (i.e., less than 5 s latency) and reliably evoke topographically invariant manding for 5 consecutive trials and (b) the participant continuously engaged with the reinforcer when it was delivered. The primary researcher terminated the MTIA early for Darcy when two mands within her repertoire met the criteria described above. When two mands for James met the criteria above, the student investigator chose to continue the assessment due to high rates of manding for other items. However, additional items did not get selected for use in the study. An exception was made for Grace in that the first two mands that occurred for five trials were selected for use in the evaluation, as invariant manding

occurred at high rates for all items. The MTIA was only conducted once for each participant. Cheese puffs and cookies were selected for James. Potato chips and M&M'S® were selected for Darcy. Pretzels and chocolate were selected for Grace.

Two new target vocal mand topographies were selected for each participant based on the assumption that either (a) the response effort was equivalent to that of the existing topography or (b) the participant had displayed more advanced expressive language skills within the assessment, or outside of the assessment as reported by a clinician. In addition, the new target mands were not observed during the MTIA. The primary researcher emailed a Speech-Language Pathologist (SLP) to volunteer to provide input on the vocal mands selected for the study. The evaluation occurred after the MTIA and prior to the onset of the intervention. The SLP was asked to provide feedback in regards to whether or not the mands selected were appropriate and understood by the English-speaking verbal community for each item. If the evaluator did not provide confirmation that the target mand topography selected was efficient, a different topography was selected using the criteria previously described. The SLP did not observe the participants at any time.

For James, 'cheese puffs' and 'cookie' were the two mands that occurred independently under their relevant EOs during the MTIA. The primary researcher chose the words 'Chips Ahoy ®' and 'chocolate-chip cookie' as target mands for cookie. The words 'cheese curls' and 'Cheetos®' were selected for cheese puffs. For Darcy, 'chips' and 'M&M'S®' were the two mands that occurred independently under their relevant EOs during the MTIA. The primary researcher chose the words 'snack' and 'more' as target mands for chips. The words 'chocolate' and 'give' were selected for M&M'S®. The mand topographies selected for Darcy took into consideration her limited vocal

language abilities as well as the lack of functional, vocal mand topographies for the two items. For Grace, the words ‘chocolate’ and ‘pretzels’ were the two phrases that occurred under their relevant EOs during the MTIA. The phrases ‘give me chocolate’ and ‘chocolate again’ were selected as target mands for ‘chocolate.’ The phrases ‘another pretzel please’ and ‘more pretzels’ were selected as target mands for ‘pretzels.’

Experimental Design

Two treatment conditions were evaluated in the study: Lag 0 and Lag 1 + TD (time delay). The treatment evaluation was conducted using a multiple baseline design across behaviors with an embedded ABAB reversal design. The first tier in the evaluation was the first mand identified in the MTIA for each participant. Data were taken during the baseline condition (Lag 0) for both tiers for all participants. The primary researcher used visual analysis to identify when to intervene on the first tier, which occurred following at least three sessions in a specific condition. During the treatment evaluation, reversals were introduced for the first tier using the same approach described. The Lag 0 schedule was implemented in the second tier until responding became stable for at least three sessions following the introduction of the intervention in the first tier. Stability was determined by visual analysis when changing conditions. No reversal occurred in the second tier. The study was terminated with each participant when the last three data points for each tier fell within 15% of the median of the three data points in the final Lag 1 + TD condition.

Procedure

The primary researcher scheduled session blocks for each participant to occur daily in the morning between 9:00 am and 11:00 am for at least three days a week. For

each day sessions were scheduled, one to four sessions were conducted with each participant. Sessions were five minutes in length, and the sequence of sessions was randomized. The session therapist provided a one-minute break with attention between sessions. Prior to each session, the therapist provided free access to the target reinforcer for 30 s. After 30 s, the therapist provided a verbal instruction prior to each session stating the requirements necessary to contact reinforcement. A timer was set to signal the end of an inter-trial interval. A trial began when the therapist placed an edible reinforcer on a napkin. Inter-trial intervals were 25 s (Silbaugh et al., 2018) for the first two sessions for James. However, due to high rates of manding during the 25 s inter-trial interval, all of the following sessions for James, and all sessions for Darcy and Grace included a 15 s inter-trial interval. During the session, the therapist did not speak when reinforcers were being delivered and did not say the target mand topographies during the session other than when prompting the target mand topography. The therapist only responded to mands for information (e.g., when is lunch) between trials, which did not occur often. The therapist did not respond to any verbal behavior in any additional context (e.g., tacts) throughout all sessions for each participant. Only the target reinforcer was present for each session. If a mand did not occur on a given trial during a session, the therapist would have withheld the reinforcer and the session would be terminated after five minutes (Silbaugh et al., 2018). However, this was never necessary. If an increase in challenging behavior was observed within a session relative to baseline levels, a session would be terminated early. If challenging behavior occurred, the session therapist blocked and redirected participants by providing the verbal instruction demonstrated at the start of each session. No sessions needed to be terminated early due to challenging behavior.

Lag 0. The session therapist delivered the specific reinforcer contingent on the first instance of manding that occurred independently every time the EO was presented (i.e., every trial). Participants were not required to vary instances of manding. No constraints were in place on the latency to mand on each trial.

*Lag 1 + TD***.** Procedures for this condition were similar to Lag 0 with exceptions. The therapist delivered the target reinforcer for the first mand that occurred each session, regardless of variability. Starting with the second trial of the first session of the Lag 1 +TD condition, reinforcement was contingent on a participant response that differed from the immediately preceding response. A progressive time delay was used to transfer stimulus control from the echoic prompt to the EO. If the participant did not vocalize a variant mand during a 2-s time delay (TD), the therapist delivered an echoic prompt. The prompt delivery was not contingent on invariant responding, but the passage of 2 s without independent variant manding. During the TD, data on invariant manding was collected and included in the calculation of manding rates. The verbal prompt delivered was selected quasi-randomly within-session, and consisted of either of the new target topographies, or the existing topography observed in the MTIA. If a variant mand did not occur following the verbal prompt, the session therapist continued to deliver the same prompt at 2 s intervals until the target mand occurred. If the first response that occurred independently is the same response that was prompted on the previous trial, it will be considered variant because it differed from the last response vocalized independently. For example, if James vocalized “cheese puffs” in a trial, received reinforcement, and vocalized “cheese puffs” again in the next trial, the therapist waited 2 s. If James did not display a variant mand independently, the therapist prompted the target “cheese curls”.

Following the verbal prompt “cheese curls”, the participant may say “cheese curls” and receive reinforcement. If, on the next trial, the participant vocalizes “cheese curls” independently, this would have been considered variant.

Progressive time delay. The length of the TD increased by 2 s every six consecutive trials within a session that zero instances of independent variant mands were observed. If an independent invariant mand occurred at the end of a session and it was not the 6th consecutive trial, the first trial of the next session for that condition began with the same TD. The last effective TD in the first implementation of the Lag 1 + TD condition was used in the second implementation of the Lag 1 + TD. For example, if a 6-s TD was effective in the last session of the first Lag 1 + TD condition, the first session of the second Lag 1 + TD used a 6-s TD. If rapid responding occurred in that two independent variant mand topographies occurred on a trial faster than the therapist could deliver the reinforcer for the first variant mand, the second mand was reinforced. That is, two reinforcers were not delivered.

Procedural Fidelity

Procedural fidelity checks were conducted to determine if the therapist followed the procedure outlined in the protocol. Data were collected using an approach similar to Silbaugh et al. (2018) for contingent delivery of reinforcement, use of prompts, and the duration of reinforcement intervals. A data sheet *(*Appendix B) was used to record the number of correct and incorrect responses for each category using tally marks. Contingent delivery of the reinforcer for the target response was considered correct if the reinforcer was delivered within 1 s following the target response, and incorrect if the reinforcer was delivered following an incorrect response or more than 1 s following the

target response. Reinforcer delivery was not scored as incorrect if delivery of the reinforcer evoked a tact response of the reinforcer delivery (i.e., Grace occasionally said 'yes' when a reinforcer was delivered). The use of prompts was assessed as correct if a prompt was delivered only after a TD and if the prompt targeted a variant topography. The duration of the reinforcement interval was scored as correct if the duration fell within ± 5 s of the 15 s inter-trial interval. Mean procedural fidelity was calculated separately for each measure by dividing the number of correct responses by the number of correct plus incorrect responses and converting the quotient to a percentage. Procedural fidelity was checked for 37% of sessions (17 out of 46 sessions) for James, 32% of sessions (16 out of 50 sessions) for Darcy and 37% of sessions (18 out of 48 sessions) for Grace. For James, mean procedural fidelity was 98% (range, 75%-100%) for contingent reinforcement delivery, 100% for use of prompts, and 98% (range, 81%-100%) for duration of reinforcement interval. For Darcy, mean procedural fidelity was 100% for contingent reinforcement delivery, 100% for use of prompts, and 100% for duration of reinforcement interval. For Grace, mean procedural fidelity was 100% for contingent reinforcement delivery, 100% for use of prompts, and 100% for duration of reinforcement interval.

Interobserver Agreement

Trained observers (i.e., data collectors) were selected based on availability and willingness to volunteer. All observers were one of the following positions throughout the study: ABA Intern, ABA Specialist, Behavior Specialist, or Board Certified Behavior Analyst. IOA data collectors must have used DataPal software at least twice prior to the study.

The student investigator provided training to observers prior to their involvement in the study. Training consisted of the student investigator emailing the session protocol to volunteers prior to their involvement with data collection at least one day in advance. The student investigator reviewed all material in person with observers, and answered all questions. Then, the primary researcher requested that each observer participate in role-play as the session therapist using two scripts. One script resembled a Lag 0 schedule of reinforcement procedure (*Appendix C*), and the additional script resembled a Lag 1 + TD schedule of reinforcement procedure (*Appendix D*). The student investigator and observer took turns as the participant and therapist in all role-play scenarios using the scripts. Corrective feedback and praise was provided in the moment.

Data collectors can be labeled as 'training,' 'reliability,' or 'primary' on DataPal. Throughout the study, a data collector was indicated as 'training' and was not labeled as 'reliability' until they reached at least 85% reliability for two consecutive sessions collecting data for all dependent variables. The student investigator was the primary data collector for all sessions.

Trained observers collected data simultaneously or by video observation for 33% of randomly selected sessions for each condition to assess interobserver agreement (IOA). Exact count-per-interval IOA was calculated for independent invariant, prompted variant, and independent variant mand topographies based on data collected independently for each selected session. Selected evaluation sessions were portioned into 10-s intervals. The primary researcher summed the number of intervals in which both observers recorded the same number of responses, and divided the sum by the total number of intervals. This quotient was then converted into a percentage. Mean IOA for

independent variant, prompted variant and independent invariant mands across conditions was 95% (range, 83% -100%), 99% (range, 93-100%) and 85% (range, 66%-100%) for James. Mean IOA across conditions for independent variant, prompted variant and independent invariant mands was 95% (range, 79% -100%), 98% (range, 89%-100%) and 90% (range, 73%-100%) for Darcy. Mean IOA across conditions for independent variant, prompted variant and independent invariant mands was 94% (range, 76% -100%), 97% (range, 93-100%) and 91% (range, 73%-100%) for Grace.

Social Validity

Social validity was assessed with indirect consumers in order to determine how satisfied they were with the intended purpose, procedures, and outcomes of the intervention using procedures similar to that of Van Norman (2005). Three indirect consumers were identified for each participant prior to the onset of the study. The indirect consumers included the following: (a) one program staff (e.g., program manager, program director, ABA Specialist, or direct support professional), (b) one family member (e.g., parent; guardian; or sibling), and (c) one activity specialist (e.g., music instructor, health and wellness instructor, or art instructor).

Prior to the onset of the study, the primary researcher read a description of the goal and procedures to the treatment evaluators *(Appendix E).* Next, the primary researcher asked the evaluators to respond to a modified version of the Treatment of Acceptability Rating Form – Revised (TARF-R; Reimers & Wacker, 1988), found in *Appendix E*. The purpose of the form was to highlight the procedure and assess indirect consumers' opinions on the goal of the proposed intervention. During an in-person interview, the primary researcher read each question and asked the evaluators to respond

using a rating scale of 1 through 7, where a rating of 1 indicates “not at all acceptable,” a rating of 4 indicates “neutral” and a rating of 7 indicates “very acceptable.” The primary researcher determined the sum of the scores from each respondent’s TARF-R, and divided the number of respondents to each question for each participant. See Table 2 for mean scores of evaluator responses for each participant, and total average scores for each question.

Question	James	Darcy	Grace	Total Average
How clear is your understanding of the suggested procedures?	6	7	7	7
How acceptable do you find the strategies to be regarding your concerns with the identified learner?	6	6	7	6
How willing are you to implement the suggested protocol as you heard it described?	7	7	7	7
Given the learner's deficits in communication, how reasonable do you find the suggested procedures?	6	7	7	7
How costly will it be to implement these strategies?	1	3	2	2
To what extent do you think there would be disadvantages in following the procedures suggested in this protocol?	2	3	2	2
How likely are the suggested procedures to make a permanent improvement in the learner's communication?	6	5	7	6
Given the learner's deficits in communication and the suggested time to implement the suggested procedures, how reasonable do you find the time requirements to be?	6	6	7	6
How confident are you that the suggested procedures will be effective?	5	6	6	6
Compared to other individuals in the program that communicate using vocal language, how serious are this learner's communication deficits?	4	6	6	5
How disruptive will it be to others to implement the suggested procedure?	3	3	1	2
How effective are these procedures likely to be for the learner?	6	5	7	6
How affordable are these procedures?	6	5	5	5
How much do you like the proposed procedures?	7	6	7	7
How willing will others that provide support to the learner be to help implement these procedures?	6	6	6	6
To what extent are undesirable side effects likely to result from these procedures?	2	3	2	2
How much discomfort is the learner likely to experience as a result of these procedures?	2	4	3	3
How willing would you be to change your routine interactions with this learner to implement these procedures?	7	7	7	7

Table 2. Average scores of the Treatment Acceptability Rating Form (Revised TARF) completed with three respondents for each participant.

CHAPTER 3

RESULTS

When the Lag 1 + TD condition was introduced for all mands, average rates of independent variant manding increased relative to baseline levels for all three participants. Variable responding was observed for James and Darcy across Lag 1 + TD sessions. Grace's pattern of responding demonstrated a therapeutic trend in the levels of all dependent variables across conditions. All participants vocalized an increase in mand topographies relative to baseline levels. The cumulative different mand topographies were identified in order to assess increases in the range of mand topographies that occurred across phases, similar to Silbaugh et al (2018). The results for all participants demonstrate an increase in the cumulative vocal mand topographies used across conditions for all mands in the study.

James. Figure 1 displays rates of independent invariant, prompted variant and independent variant manding across conditions for two mands (Cheese Puffs: top panel; Cookies; bottom panel) by James. Rates of independent invariant manding averaged 13 responses per minute (RPM), range (8.1 – 20 RPM) during Lag 0 for Cheese Puffs. We observed zero independent variant mands during Lag 0 for Cheese Puffs. For Cookies, high, steady rates of independent invariant mands (M =13 RPM; range: 10.93– 14.72 RPM) and low rates of independent variant mands with a range of 0-1.03 RPM were observed during Lag 0. Introduction of Lag 1 + TD for Cheese Puffs demonstrated an immediate increase in the rates of independent variant mands relative to baseline levels; however, rates of independent invariant mands remained consistent with Lag 0. The duration of the TD was 2-s for the first 4 sessions of Lag 1 + TD. Rates of all three

dependent variables for Cheese Puffs held constant for the third through fifth sessions of Lag 1 + TD, although the duration of the TD was increased from 2-s to 4-s during the fifth session. Lag 1 + TD was introduced in Cookies and the duration of the TD increased from 4-s to 6-s during the sixth Lag 1 + TD session, which coincided with an increase in rates of independent invariant manding in Lag 1 + TD for Cheese Puffs. A return to Lag 0 for Cheese Puffs while Lag 1 + TD was held constant for Cookies demonstrated that for Cheese Puffs, rates of independent invariant mands returned to initial Lag 0 levels and rates of independent variant mands increased from initial Lag 0 levels of 0 RPM to an average of 1 RPM. Reintroduction of Lag 1 + TD for Cheese Puffs displayed a replication of the effects observed during the first Lag 1 + TD. While Lag 1 + TD for Cookies demonstrated an immediate increase in rates of independent variant mands relative to Lag 0 levels, rates of independent invariant mands remained high and consistent with Lag 0 levels across all Lag 1 + TD sessions for Cookies. Prompts were delivered for all 28 of Lag 1 + TD sessions.

For Cheese Puffs, James's range of variant responding was 0-1.17 RPM in Lag 0. There were 14 Lag 1 + TD sessions, and 13 data points exceeded the range of responding found in the baseline phases. Therefore, PND for Cheese Puffs was 93% (13/14 x 100%). For Cookies, variant mands occurred with a range of 0-1.03 RPM. James participated in 14 Lag 1 + TD sessions for Cookies, and all of the data points exceeded the range of responding found in baseline phases. Therefore, PND for Cookies was 100% (14/14 x 100 = 100%).

Figure 2 displays the cumulative different mand topographies for Cheese Puffs and Cookies observed across conditions for James. James engaged in one vocal mand

topography (“cheese puffs”) during baseline for Cheese Puffs. An immediate increase in independent responding with novel mand topographies was observed with the introduction of Lag 1 + TD. In total, seven vocal mand topographies were observed for Cheese Puffs starting at Session 10. For Cookies, James engaged in two vocal mand topographies (“cheese puffs” and “cheese puffs please”) during baseline. The Lag 1 + TD demonstrated an increase in the use of novel mand topographies, with 12 different topographies observed by the end of the evaluation for Cookies.

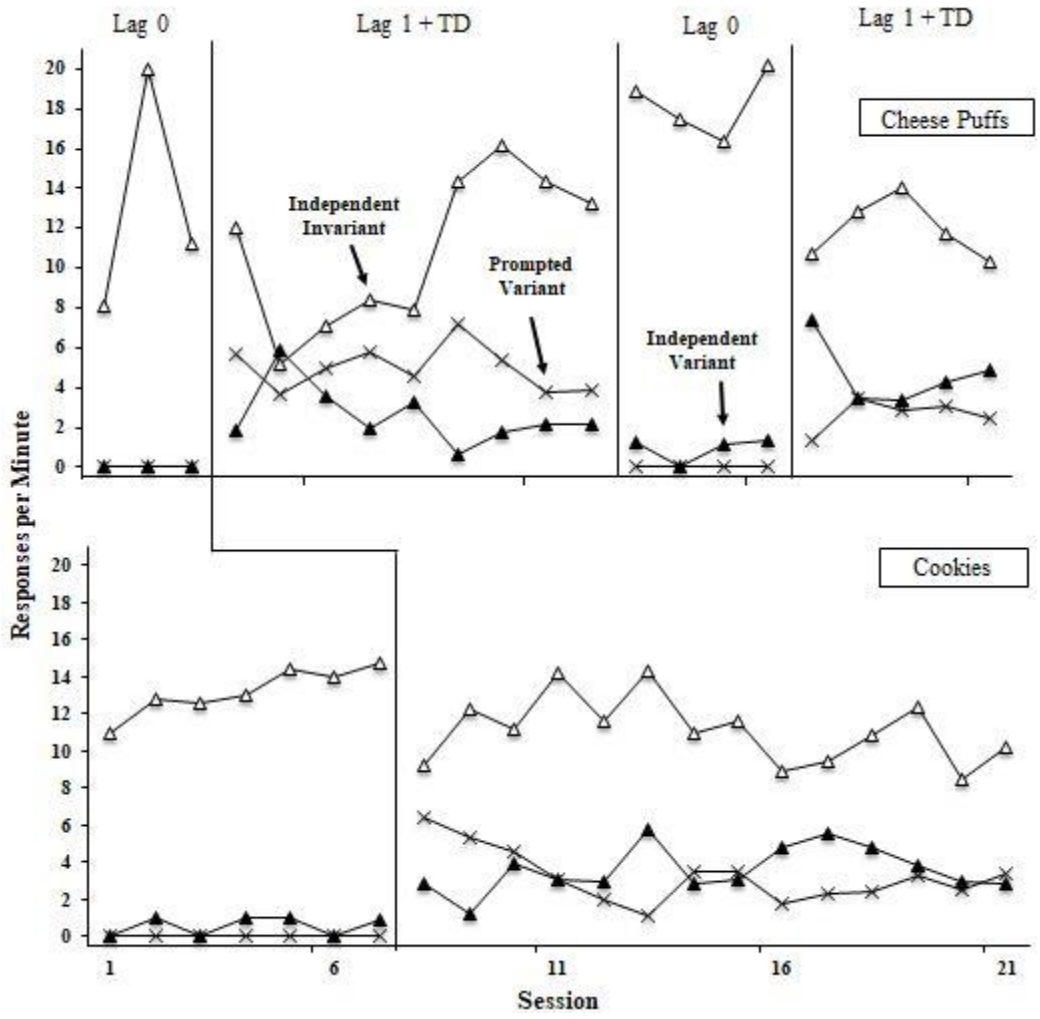

Figure 1. Rates of independent invariant, prompted variant and independent variant mand responses across conditions during Cheese Puffs and Cookies for James.

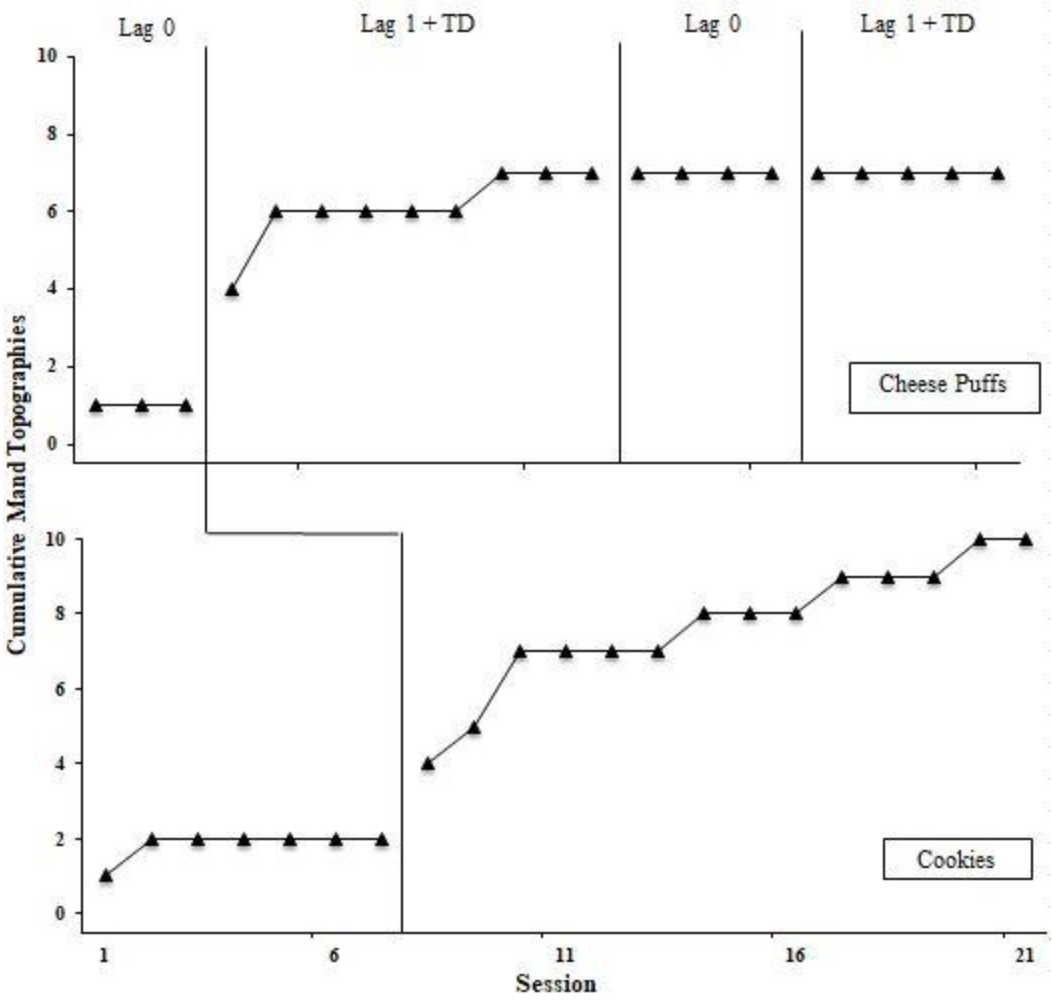

Figure 2. Cumulative mand topographies that occurred across conditions during Cheese Puffs and Cookies for James.

Darcy. Figure 3 displays rates of independent invariant, prompted variant and independent variant manding across conditions for two mands (Chips: top panel; M&M'S®; bottom panel) by Darcy. Low rates of independent variant mands were observed in Lag 0 for Chips, and the mean of independent invariant manding was 3 RPM (range, 2.1 – 4.1 RPM). For M&M'S®, high variability was observed in Lag 0 (range, 2.35 – 15.27) for rates of independent invariant manding. Rates of independent variant manding were low for M&M'S® (M: 1.2 RPM; range: 0 –2.56 RPM) in Lag 0. Introduction of Lag 1 +TD for Chips demonstrated a variable pattern of responding and an overall increase in the average rates of all three dependent variables relative to Lag 0 levels. During Lag 1 + TD for Chips, average independent variant mands was 3.54 RPM (range; 1.1 – 6.15 RPM); average independent invariant mands was 5.25 RPM (range; 1.12 – 8.74 RPM); and average prompted variant mands was 4.34 (range; 2.73 – 5.62 RPM). The Lag 1 + TD condition was introduced in M&M'S® and variable responding was observed for independent variant mands (M = 5.03; range = 1.52 – 8.94 RPM); prompted variant mands (M = 4.74; range = 2.68 – 6.73); and independent invariant mands (M = 7.4; range = 2.5 – 14.19). A return to Lag 0 in Chips when Lag 1 + TD for M&M'S® was in place demonstrated rates of independent variant mands and independent invariant mands similar to that of the preceding Lag 1 + TD condition. Reintroduction of Lag 1 + TD for Chips coincided with a similar pattern of responding observed in the initial Lag 1 + TD for Chips. Prompts were delivered for all 31 of Lag 1 + TD sessions. The TD remained at 2 s for all Lag 1 + TD M&M'S® sessions, and

increased from 2 s to 4 s during the 10th session for Chips. The TD remained at 4 s for all of the following Lag 1 + TD sessions for Chips.

For Chips, Darcy's range of variant responding was 0-4.26 RPM in Lag 0. There were 15 Lag 1 + TD sessions, and four data points exceeded the range of variant responding found in the baseline phases. Therefore, PND for Chips was 26% (4/15 x 100 = 26%). For M&M'S®, variant mands occurred with a range of 0-2.56 RPM. Darcy participated in 16 Lag 1 + TD sessions for M&M'S®, and 15 data points exceeded the range of variant responding found in baseline phases. Therefore, PND for M&M'S® was 93% (15/16 x 100 = 93%).

Figure 4 displays the cumulative different mand topographies for Chips and M&M'S® observed across conditions for Darcy. Darcy displayed two vocal mand topographies ("Chips" and "I want") during baseline for Chips. With the introduction of Lag 1 + TD, an immediate increase in the independent use of novel mand topographies was observed, with nine topographies displayed in total for Chips. For M&M'S®, "I want," "want more," and "M&M'S®" were the three vocal mands observed during baseline. The Lag 1 + TD for "M&M'S®" demonstrated an increase in independent responding with different mand topographies. The cumulative total of different vocal mand topographies observed for M&M'S® was 14 topographies by the end of the study.

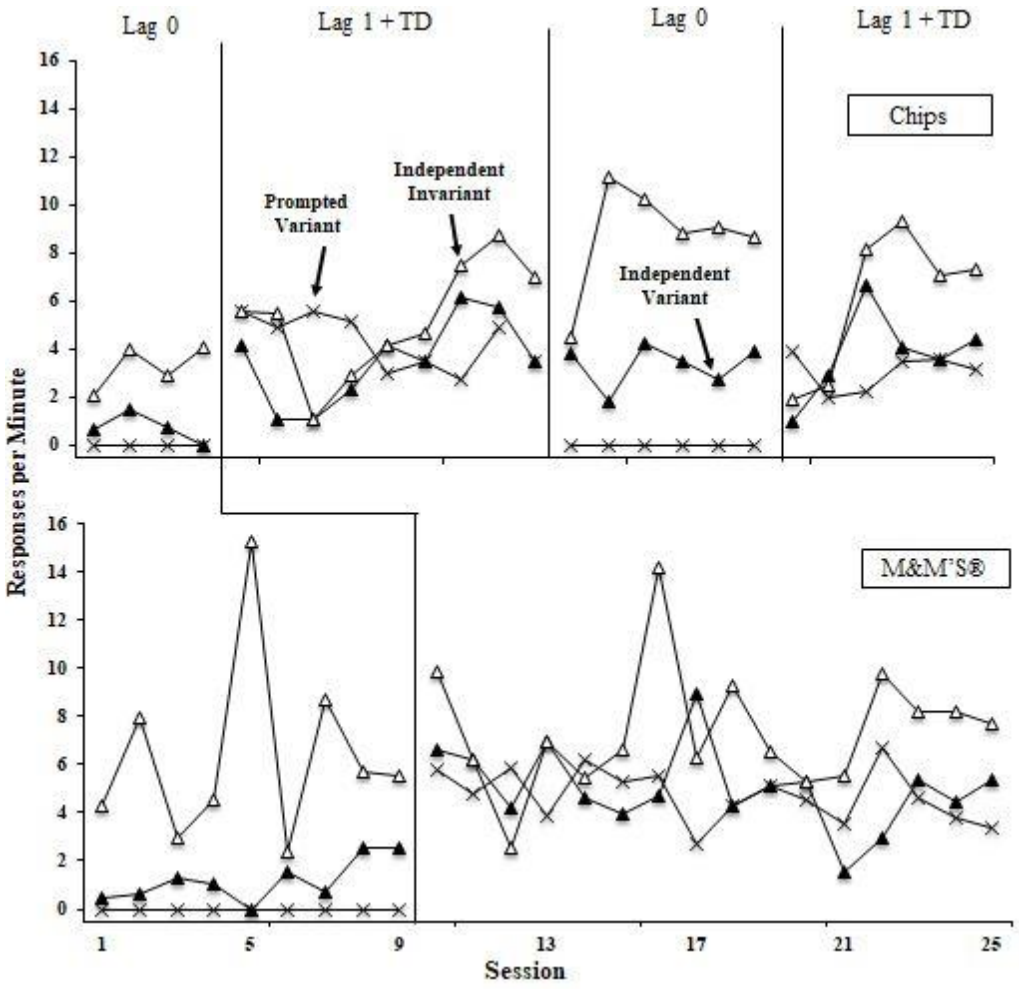

Figure 3. Rates of independent invariant, prompted variant and independent variant mand responses across conditions during Chips and M&M'S® for Darcy.

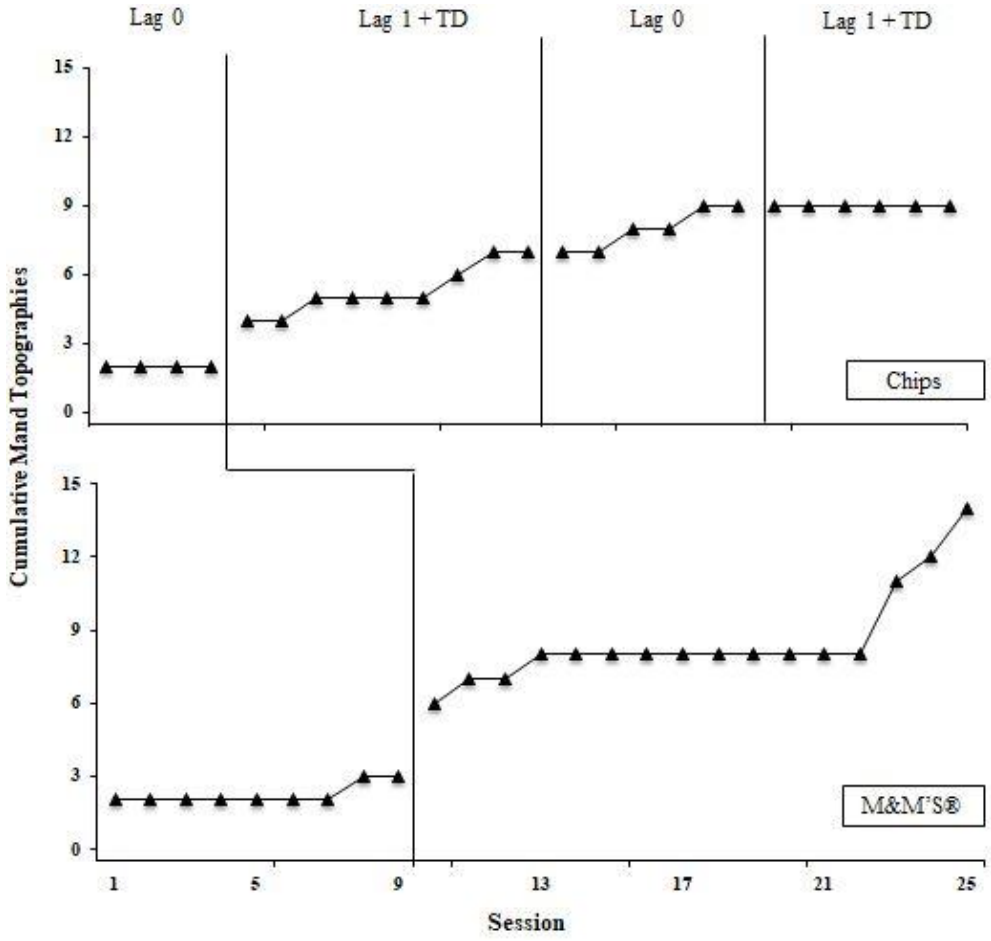

Figure 4. Cumulative mand topographies that occurred across conditions during Chips and M&M'S® for Darcy.

Grace. Figure 5 displays rates of independent invariant, prompted variant and independent variant manding across conditions for two mands (Pretzels: top panel; Chocolate; bottom panel) by Grace. High rates of independent invariant mands (M = 13.53; range = 11.84 – 16.67 RPM) were observed in Lag 0 for Pretzels, where independent variant mands were near zero (range; 0 – 0.93 RPM). For Chocolate, high rates of independent invariant mands (M =14.45 RPM; range: 11.82– 18.11 RPM) and low rates of independent variant mands (M = 1.12; range: 0 – 3.85 RPM) were observed during Lag 0. An immediate increase in the rates of independent variant mands (M =3.96; range = 2.23 – 6.44 RPM) was observed with the introduction of Lag 1 + TD in Pretzels. Rates of independent invariant mands (M = 5.9; range = 4.83 – 7.26 RPM) decreased relative to Lag 0 levels for Pretzels. Lag 1 + TD for Chocolate coincided with an increase from Lag 0 in the average rate of independent variant mands (M = 3.8 RPM; range = 1.53 – 7.36 RPM) and a decrease in the average rate of independent invariant mands (M = 6.71; range = 4.76 – 9.18 RPM). A return to Lag 0 for Pretzels while Lag 1 + TD was held constant for Chocolate demonstrated a pattern of responding similar to that of the initial Lag 0 condition for Pretzels. The reintroduction of Lag 1 + TD for Pretzels coincided with rates of manding similar to that of the initial Lag 1 + TD. Prompts were delivered for all 34 of Lag 1 + TD sessions. The TD remained at 2 s until increasing to 4 s during the 11th session for Pretzels, and remained at 4 s for all of the following Lag 1 + TD sessions for Pretzels. For Chocolate, the TD increased from 2 s to 4 s during the 10th session, increased from 4 s to 6 s during the 14th session, and increased

from 6 s to 8 s during the 15th session. All of the remaining Lag 1 + TD sessions started and ended with the 8 s TD for Chocolate.

For Pretzels, Grace's range of variant responding was 0-1.02 RPM in Lag 0. There were 16 Lag 1 + TD sessions, and all data points exceeded the range of variant responding found in the baseline phases. Therefore, PND for Pretzels was 100% (16/16 x 100 = 100%). For Chocolate, variant mands occurred with a range of 0-3.85 RPM. Grace participated in 18 Lag 1 + TD sessions for Chocolate, and eight data points exceeded the range of variant responding found in baseline phases. Therefore, PND for Chocolate was 44% (8/18 x 100 = 44%).

Figure 6 displays the cumulative different mand topographies for Pretzels and Chocolate observed across conditions for Grace. Grace demonstrated two vocal mand topographies during baseline for Pretzels ("one pretzel" and "pretzels"). During Lag 1 + TD for Pretzels, an immediate increase in the independent responding of novel mand topographies was observed, with 10 total topographies observed by the end of the evaluation. For Chocolate, three different topographies were observed during baseline ("one chocolate" "chocolate" and "chocolate please"). The Lag 1 + TD demonstrated an increase in the use of novel mand topographies, with 12 different topographies observed by the end of the evaluation for Chocolate.

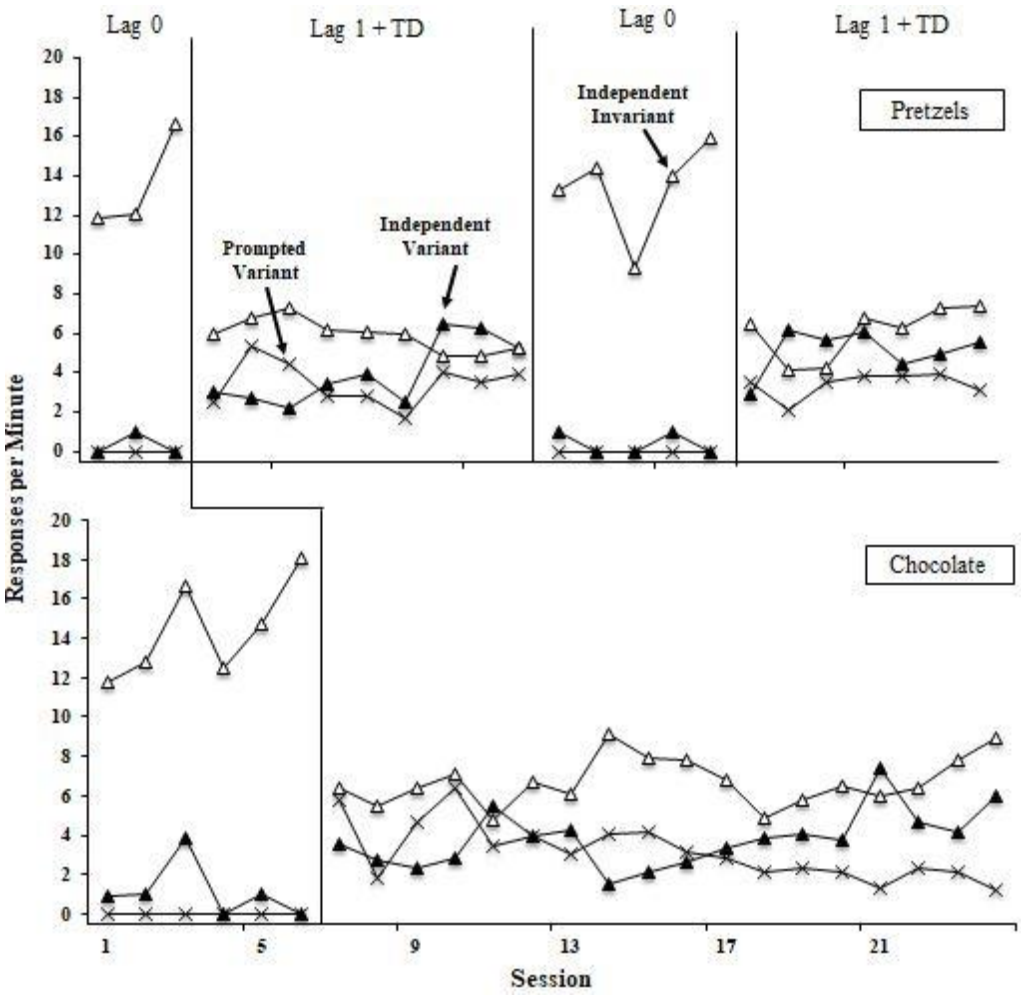

Figure 5. Rates of independent invariant, prompted variant and independent variant mand responses across conditions during Pretzels and Chocolate for Grace.

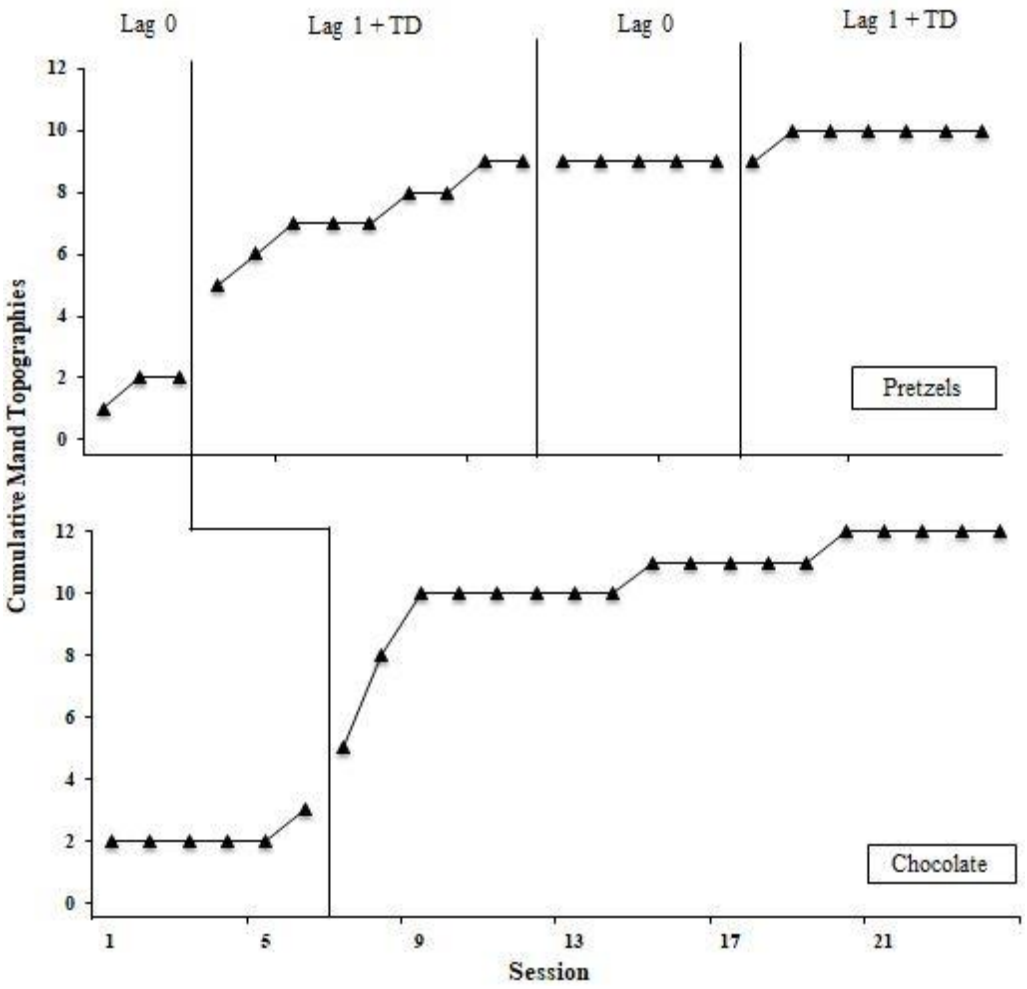

Figure 6. Cumulative mand topographies that occurred across conditions during Pretzels and Chocolate for Grace.

CHAPTER 4

DISCUSSION

The current study examined the effects of a lag schedule of reinforcement and progressive time delay for three adults with autism. An MTIA was conducted with each participant to identify new and existing vocal mand topographies. Two conditions were used in the evaluation to assess variable responding when variability was (Lag 1 + TD) and was not (Lag 0) required to produce reinforcement (Silbaugh et al 2018). The participants were provided with an opportunity to contact reinforcement at the start of every trial during Lag 1 + TD, before a prompt was delivered. If an independent variant vocal mand did not occur by the end of the TD, a prompt targeting a variant vocal mand was delivered. Responding was differentially reinforced and contingent on prompted and independent variant mand topographies.

Only two other studies have evaluated the effects of lag schedules of variability without focusing on the treatment of challenging behavior (Silbaugh et al, 2018; Brodhead et al, 2016). The current study was distinct from previous research by Silbaugh et al (2018) and Brodhead et al (2016) in several ways. First, only few studies have focused on the implementation of a lag schedule on mand variability by children with ASD, and no studies to date have examined variable responding by adults with ASD. Silbaugh et al (2018) assessed the effects of lag schedules on functionally-equivalent topographies using echoic prompts, and Brodhead et al (2016) evaluated the effects of lag schedules on mand frame variability in the presence of multiple reinforcers using scripts. Textual repertoires were not evaluated in the current study. Echoic prompts were used

combined with lag schedules to target new topographies during training, and to keep procedures consistent across participants with different verbal behavior repertoires.

The study expanded previous findings in that the use of a lag schedule promotes variable responding during contexts in which reinforcement is delayed (Silbaugh et al. 2018). The investigator followed procedures similar to that of Silbaugh et al (2018), with the exception of shorter inter-trial intervals and including mand frames in the evaluation for one participant. Additionally, edible reinforcers were used for all six mands in the evaluation, whereas Silbaugh et al (2018) only used one edible reinforcer. However, the current study is consistent with previous findings in that unless the environment is arranged to promote mand variability, individuals may not vary their responding (Silbaugh et al. 2018).

In an effort to lower the effects of confounding variables, the inter-trial interval was consistent for all mands for each participant. High rates of responding were observed during inter-trial intervals, suggesting that discrimination failure and history of reinforcement may have contributed to the lack of discriminative stimulus control displayed by James and Darcy. The inter-trial interval may have also served as a period of extinction for James and Darcy, as the edible reinforcers were consumed quickly, and manding continued throughout the remainder of the interval. Similar to Silbaugh et al (2018), we observed that the TD component of the intervention might have also served as a period of extinction, as multiple responses were allowed on trials. That is, the echoic prompt was delivered when the TD elapsed, and not contingent on an invariant topography that would not contact reinforcement. Variables that influence mand variability, such as delivering prompts contingent on invariant instances of manding, may

be examined in future research. A recommendation made by Silbaugh et al (2018) that was not followed by this study is that replications may consider a trial-based evaluation, such as 10 trials per session as opposed to a 5-minute session.

In the current study, considerations had to be made to select two vocal mand topographies that were socially valid, as opposed to targeting functional equivalence. We also prioritized selecting topographies based on skill level and response effort. For example, we chose "snack" and "more" for Chips for Darcy because the two mands were equal in response effort, and there were not two socially valid, functionally equivalent vocal topographies identified for "Chips." Further, contextually inappropriate mands (e.g., saying "thank you" in the presence of cheese puffs) were reinforced. This could also be considered a limitation of the procedures, as these mands were not relevant to clinical practice. Future research should determine ways to assess within-class topographical mand variability when one or less functionally equivalent topographies is identified for a single reinforcer.

Social validity of the goals and procedures was assessed for the participants; however, the current study did not assess the outcomes of the evaluation. It is unknown if the participants benefited from their participation in the study. Second, generalization and maintenance was not assessed. Future research may consider assessing the effectiveness of the intervention in these ways, which was not done in this study.

A final limitation to the study is similar to that of Silbaugh et al (2018), which raises a question for future research in using lag schedules to increase mand variability. That question is, to what extent is the increase in mand variability attributed to the lag schedule under the Lag 1 + TD? During the intervention, reinforcement was delivered for

any response that different from the previous independent mand topography during session time. Therefore, variant mand topographies were not reinforced during inter-trial intervals, and reinforcement was only available for variant mands that occurred in the presence of the reinforcer. Future research should determine various ways to arrange a lag schedule in mand training to address the effects of topographical variability in practical ways.

Many individuals with autism engage in repetitive behaviors, which is conceptualized as invariant behavior. Some examples of invariant behavior displayed by individuals with autism include using the same words or tone of voice when requesting items. Common mand training uses a fixed ratio (FR) 1 schedule of reinforcement, where invariant responding can occur when one mand is taught for a single reinforcer. In an FR 1 schedule of reinforcement, reinforcement is delivered following one correct response. That is, a learner may be taught the vocal mand, 'drink' for a cup of water, and receive reinforcement for saying, 'drink' every time the correct response occurs. Learning to vary one's responses may be beneficial when one response is placed on extinction, and a loss of reinforcement occurs. If a learner says, 'drink' as a mand for water, and the listener provides a different beverage or does not provide reinforcement, the learner may need to respond in a different way to gain access to their wants and needs. Clinical practice may utilize a lag schedule of reinforcement to teach variability in responding during mand training. When clinicians are assessing invariance concerns in practice, an MTIA could be conducted to determine what invariant vocal mand responses are in the current repertoire of the individual. Although the current study did not focus on challenging

behavior, the current procedures may also inform FCT practice and research in regards to teaching multiple response exemplars during training.

Further evaluations of the effects of lag schedules of reinforcement may help inform practice for the treatment of invariance problems, and provide insight for teaching variant manding when changes in social contingencies occur. The effects of reinforcing mand variability on the verbal repertoires of learners should continue to be assessed by future research.

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APPENDIX A

Participant #:

MAND TOPOGRAPHY INVARIANCE ASSESSMENT

Date Initiated:
Student Investigator: Krista Paranczak

Session Duration: _____ minutes

Items:

1. 6.
2. 7.
3. 8.
4. 9.
5. 10.

Trial #:	Vocal Request:	Item Requested:	Notes:
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
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24			
25			
26			
27			
28			
29			
30			

APPENDIX B

Participant #: Date:
Session #:

PROCEDURAL FIDELITY

Primary Researcher: Krista Paranczak

Evaluator Initials:	Therapist Initials:	
Condition (circle one):	Lag 0	Lag 1 + TD

Data Collection:

Target behavior:	Correct response:	Incorrect response:	Measurement
Contingent reinforcement delivery	Any occurrence of reinforcement delivered within 1 s following the target response.	Any occurrence of reinforcement delivered following an incorrect response or more than 1 s following the target response.	Frequency (Percent Occurrence)
Use of prompts	Any occurrence of a prompt delivered only after a TD and targets a variant topography.	Any occurrence of a prompt delivered before a TD, or targets an invariant topography.	Frequency (Percent Occurrence)
Duration of reinforcement interval	Any occurrence of a reinforcement interval that falls within ± 5 s of 15 s.	Any occurrence of a reinforcement interval that does not fall within ± 5 s of 15 s.	Frequency (Percent Occurrence)

Target behavior:	Correct:	Incorrect:	% Correct (#correct/total* 100)
Contingent reinforcement delivery			
Use of prompts			
Duration of reinforcement interval			

APPENDIX C

MAND VARIABILITY PROTOCOL – STAFF TRAINING

Date Initiated:
Primary Researcher: Krista Paranczak

Script 1 – Lag 0 Condition
Participants: Therapist, Participant 1
Materials: Script, table, two chairs, tangible items (hypothetical reinforcers)

Pre-session access:

1. **Therapist**: Say, "[name of participant], you can have [target item] for 30 seconds. After 30 seconds, you can ask for more."
2. **Participant**: Engages with items.
3. **Therapist** removes items after 30 seconds

Session: **data collection starts now*

4. **Therapist** sits at table withholding target items.
5. **Participant:** Say, "[item name]"
6. **Therapist** delivers item**.**
7. **Participant** engages with item.
8. **Therapist** removes item after 15 s.
9. **Participant:** Say, "[item name]"
10. **Therapist** delivers item**.**
11. **Participant** engages with item.
12. **Therapist** removes item after 15 s.

Continue to repeat Steps 4 through 12 until the 5-minute session timer buzzes. Session will then be terminated.

APPENDIX D

MAND VARIABILITY PROTOCOL – STAFF TRAINING

Date Initiated:
Primary Researcher: Krista Paranczak

Script 2 – Lag 1 + TD Condition
Participants: Therapist, Participant 1
Materials: Script, table, two chairs, tangible items (hypothetical reinforcers)

Pre-session access:

1. **Therapist**: Say, "[name of participant], you can have [target item] for 30 seconds. After 30 seconds, you can ask for more."
2. **Participant**: Engages with item.
3. **Therapist** removes items after 30 seconds

Session: **data collection starts now*

4. **Therapist** sits at table withholding target items.
5. **Participant:** Say, "[item name 1]"
6. **Therapist** delivers item**.**
7. **Participant** engages with item.
8. **Therapist** removes item after 15 s.
9. **Participant:** Say, "[item name 1]"
10. **Therapist:** Wait 2 seconds. Say, "[item name 2]"
11. **Participant:** Say, "[item name 2]"
12. **Therapist** delivers item.
13. **Participant** engages with item.
14. **Therapist** removes item after 15 s.
15. **Participant:** Say, "[item name 2]"
16. **Therapist** delivers item.
17. **Participant** engages with item.
18. **Therapist** removes item after 15 s.
19. **Participant:** Say, "[item name 2]"
20. **Therapist:** Wait 2 seconds. Say, "[item name 1]"
21. **Participant:** Say, "[item name 1]"
22. **Therapist** delivers item.
23. **Participant** engages with item.
24. **Therapist** removes item after 15 s.
25. **Participant**: Say, "[item name 2]"
26. **Therapist:** Wait 2 seconds. Say, "[item name 1]"
27. **Participant:** Say, "[item name 1]"
28. **Therapist** delivers item.
29. **Participant** engages with item.
30. **Therapist** removes item after 15 s.
31. **Participant:** Say, "[item name 1]"
32. **Therapist** delivers item.
33. **Participant** engages with item.
34. **Therapist** removes item after 15 s.

Repeat Steps 4 through 35 until the 5-minute session timer buzzes. Session will then be terminated.

APPENDIX E

Treatment Acceptability Rating Form (Revised TARF)
By Thomas Reimers and David Wacker (1988)
Modifed by Susan Silvestri (2003) and Renee Van Norman (2004)
Modified by Krista Paranczak (2019)

Description of procedures

Participant # has been selected as a participant for this study because he/she does not consistently use more than one vocal response in making requests for an item or activity. The purpose of this study is to evaluate the effectiveness of a procedure to teach Participant # to vary his/her vocal requests for two items when a prompt is delayed.

First, we assessed what items Participant # is motivated to ask for. We found that when Participant # was presented with an array of preferred items, he/she consumed gummies and cookies quickly after they were received. In addition, we found that Participant # asks for these items by vocalizing the words "gummy" and "cookie" only. Therefore, we will teach Participant # two new vocal responses to use for these two items.

We will begin the evaluation by giving Participant # the item he/she requests for every time he/she requests for the item independently in a 5 minute session.

Then, we will teach Participant # two new vocal requests. To teach this, the therapist will wait 2 seconds. If Participant # does not respond with a new request in 2 seconds, the therapist will provide a verbal prompt. We will provide the item requested if Participant # vocalizes a different request from the previous request. For example, Participant # may be taught to say "candy" as a new response for requesting a gummy using this procedure. The delay may be increased over trials if Participant # does not begin to independently use new words or word structure to make requests.

Finally, we will use the same procedure to teach a variety of vocal responses for the other item that was identified.

DIRECTIONS:
Please listen to the procedure description and then complete the questionnaire provided. The questionnaire should be completed by placing a check mark on the line under the question that best indicates how you feel about the procedure you just heard.

If you have any concerns that you would like to address with the author of the protocol, please provide specific feedback on the questionnaire under the question in which you have specific concerns.

If a question does not apply to you, or you do not wish to answer, please write N/A next to the question indicating that the question has been read.

Thank you in advance. Your opinions and feedback will help us to provide effective treatment for the individuals we support.

Sincerely,

Krista Paranczak

Date completed: _____

Name (optional): _____

Relation to learner: _____

Treatment Acceptability Rating Form (Revised TARF)
By Thomas Reimers and David Wacker (1988)
Modifed by Susan Silvestri (2003) and Renee Van Norman (2004)
Modified by Krista Paranczak (2019)

1. How clear is your understanding of the suggested procedures?

_____	_____	_____	_____	_____	_____	_____
Not at all clear			Neutral			Very clear

---

2. How acceptable do you find the strategies to be regarding your concerns with the identified learner?

_____	_____	_____	_____	_____	_____	_____
Not at all acceptable			Neutral			Very acceptable

---

3. How willing are you to implement the suggested protocol as you heard it described?

_____	_____	_____	_____	_____	_____	_____
Not at all willing			Neutral			Very willing

---

4. Given the learner's deficits in communication, how reasonable do you find the suggested procedures?

_____	_____	_____	_____	_____	_____	_____

Not at all reasonable | Neutral | Very reasonable

---

5. How costly will it be to implement these strategies?

_____ _____ _____ _____ _____ _____ _____

Not at all costly | Neutral | Very costly

---

6. To what extent do you think there would be disadvantages in following the procedures suggested in this protocol?

_____ _____ _____ _____ _____ _____ _____

Not at all likely | Neutral | Very likely

---

7. How likely are the suggested procedures to make a permanent improvement in the learner's communication?

_____ _____ _____ _____ _____ _____ _____

Not at all likely | Neutral | Very likely

---

8. Given the learner's deficits in communication and the suggested time to implement the suggested procedures, how reasonable do you find the time requirements to be?

_____ _____ _____ _____ _____ _____ _____

Not at all reasonable | Neutral | Very reasonable

---

9. How confident are you that the suggested procedures will be effective?

_____ _____ _____ _____ _____ _____ _____

Not at all confident | Neutral | Very confident

---

10. Compared to other individuals in the program that communicate using vocal language, how serious are this learner's communication deficits?

_____ _____ _____ _____ _____ _____ _____

Not at all serious | Neutral | Very serious

---

11. How disruptive will it be to others to implement the suggested procedure?

____	____	____	____	____	____	____
Not at all disruptive			Neutral			Very disruptive

---

12. How effective are these procedures likely to be for the learner?

____	____	____	____	____	____	____
Not at all effective			Neutral			Very effective

---

13. How affordable are these procedures?

____	____	____	____	____	____	____
Not at all affordable			Neutral			Very affordable

---

14. How much do you like the proposed procedures?

____	____	____	____	____	____	____
Do not like them at all			Neutral			Like them very much

---

15. How willing will others that provide support to the learner be to help implement these procedures?

____	____	____	____	____	____	____
Not at all willing			Neutral			Very willing

---

16. To what extent are undesirable <u>side effects</u> likely to result from these procedures?

____	____	____	____	____	____	____
Not at all likely			Neutral			Very likely

---

17. How much <u>discomfort</u> is the learner likely to experience as a result of these procedures?

____	____	____	____	____	____	____

No discomfort at all	Neutral	Very much discomfort

18. How willing would you be to change your routine interactions with this learner to implement these procedures?

_____	_____	_____	_____	_____	_____	_____
Not at all willing			Neutral			Very willing