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Increasing Variable Play in Children with Autism Using a Lag Schedule and Stimulus Fading

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Abstract

Restricted or repetitive interests are one of the hallmark characteristics of an autism diagnosis, and this characteristic can sometimes be present in a child's toy-play. The current study explored the effects of a lag schedule and visual discriminative stimuli on the variability of selection of play items for two children with autism. The researcher used an ABAB reversal design to reinforce variability in play selection and then slowly and systematically faded the stimuli associated with the intervention. The results were idiosyncratic across participants. For one subject, the lag schedule alone maintained variable selection of toys, and the visual discriminative stimuli were successfully faded from the intervention package. For another subject, the intervention was ineffective in evoking variable play.

Keywords: variability, rigid responding, play skills, lag schedule, stimulus fading

Introduction

Variable responding can be functional across organisms in that its application can aid in problem solving, creativity, and generative learning (Neuringer, 2002). A person might contact reinforcement more readily if they have multiple responses to emit in the case that their typical response fails (Cooper, Heron & Heward, 2007). For example, if a person wants a glass of water, it might be helpful to have several responses to access that water in their repertoire: asking someone for water, getting a bottled water from the refrigerator, or filling up a glass with tap water from the sink. In the event that another person is not available to mediate that initial mand for water, there are several other responses that could contact reinforcement. However, without a history of reinforcement for responding variably, responding might cease after the first response does not get reinforced.

More specifically, variability can be advantageous in helping children with autism to contact a larger number and variety of reinforcers. One of the two core symptoms for an autism diagnosis includes that the client must engage in restricted and repetitive patterns of behavior, interests or activities (American Psychiatric Association [APA], 2013). Several studies have demonstrated that compared to their typically developing peers, children with autism respond with less variability, even if it means a loss in reinforcement (Miller & Neuringer, 2000; Mullins & Rincover, 1985). For instance, during designated free play, a child with autism might choose to engage with only a limited number of items or engage in little variation of play type with a specific item (e.g., rolling a car back and forth versus having two cars race). Hanley, Iwata, Roscoe, Thompson and Lindberg (2003) conceptualized rigid selection of leisure items as not necessarily an example of an individual's autonomy but as an example of an individual's limited learning history. Identifying methods to promote varied response allocation (i.e., preferences)

might provide practitioners a way to incorporate novel and potentially reinforcing items into an individual's learning history.

There has been a fairly recent peak of interest within the applied literature regarding variability as an operant in children with autism (Wolfe, Slocum, & Kunnavatana, 2014), though the idea was initially theorized earlier in the basic research. Page and Neuringer (1985) identified that variability was an operant dimension of behavior much like any other operant dimension (e.g., rate, duration, topography) that could be manipulated by environmental contingencies. Though this study observed the effects of reinforcement on increasing the variability of the order of key-pecking behavior in pigeons, the results have been replicated in both human-operant and applied research.

The Page and Neuringer (1985) study, as well as many other studies on variability, used a lag schedule of reinforcement to promote variable responding. In lag schedules, reinforcement is delivered contingent on a response differing from the previous *n* number of responses. For instance, if a client is engaging in rote greeting behavior, a Lag-2 schedule might be used to reinforce variable responding to the phrase "Hello." If, in the first trial, the client emitted the response "Hi," and in the second trial emitted the response "Hello," the phrases "Howdy" or "Hey there" would produce reinforcement in the third trial, whereas "Hi" and "Hello" would not produce reinforcement.

Despite the literature regarding operant variability in children with autism, many different avenues related to the topic need to be explored. One avenue that still needs to be researched is the use of different fading procedures (e.g., stimulus fading) to promote variable responding in the absence of visual supports.

Review of the Literature

The basic and applied literature have studied the topic of variability in depth. Research regarding variability has spanned across a variety of subjects, topographical responses and interventions used to improve variability.

Basic Research on Variability as an Operant

Early in the basic literature, researchers identified that creativity could be manipulated by environmental contingencies. For example, Pryor, Haag and O'Reilly (1969) evoked creative behavior in a porpoise by making reinforcement contingent on "spontaneous activity." Rather than explicitly shaping or providing differential reinforcement of closer approximations to a novel response, the researchers in this study reinforced any occurrence of behavior that was different than behavior that was emitted in the past. Essentially, the researches established a new "creativity" response class for the porpoise which evoked a wide variety of novel responses such as tail-slapping and flipping. Several behaviors that were evoked by Pryer et al. (1969) were unable to be shaped by animal trainers prior to the onset of the study indicating that reinforcing novelty might be an effective intervention.

In their seminal study, Page and Neuringer (1985) discovered that the variability of behavior could be manipulated by the environment similarly to any other operant dimension of behavior (e.g., frequency, magnitude). The researchers in this study looked at the effects of reinforcement on variable key pecking by pigeons. During the experiment, Page and Neuringer (1985) placed pigeons into operant chambers that contained two response keys: one on the left side of the chamber and the other on the right side of the chamber. The pigeons' first eight responses were recorded, and the researchers reinforced key pecking in any given trial so long as it varied from the last *n* number of pecking combinations. For example, in the first trial, the

pigeon pecking LRLRLRLR might receive reinforcement whereas in the next trial, any combination other than LRLRLRLR might produce reinforcement for that pigeon. The researchers in this study were able to increase the lag schedule to a Lag-50 in which pecking combinations were only reinforced if they differed from the last 50 combinations. Page and Neuringer (1985) found that when the delivery of reinforcement was contingent on variable key pecking, variability maintained at high levels. However, when delivery of reinforcement was contingent on key pecking only, regardless of whether or not the responses differed from previous session combinations, variable pecking was not demonstrated.

The research on variability has also expanded into the human-operant arena. Miller and Neuringer (2000) utilized a percentile-ratio reinforcement schedule to reinforce variable button presses by children with autism. In a percentile-ratio reinforcement schedule, in which reinforcement is contingent on variable responding, responding only produces reinforcement if it differs from the relative frequency of that same response in previous trials. For example, in the Miller and Neuringer (2000) study, subjects were asked to play a computer game in which left and right button presses were recorded. Button-pressing combinations only produced reinforcement if they differed from the combinations that occurred for less than 35% of all previous combinations emitted throughout the study. Similar to the results obtained by Page and Neuringer (1985), Miller and Neuringer (2000) found that, across groups, when reinforcement was delivered contingent on variable responding, more variability was observed. Both of these studies demonstrate that the delivery of reinforcement can control levels of variability.

Applied Procedures in Promoting Variability

Applied research has evaluated the effects of various methods on increasing variability across several topographies of behavior including mand frames (Brodhead, Higbee, Gerenscer &

Akers, 2016; Sellers, Kelley, Higbee & Wolfe, 2015), play skills (Miller & Neuringer, 2000; Napolitano, Smith, Zarcone, Goodkin & McAdam, 2010), intraverbals (Carroll & Kodak, 2015; Contreras & Betz, 2016; Lee & Sturmey, 2006), and tacts (Heldt & Schlinger, 2012). Previous research on promoting variability has used two primary methods: differential reinforcement, including the utilization of lag schedules, and using visual discriminative stimuli as prompts (Wolfe et al., 2014).

Consequent Interventions

Differential reinforcement. Differential reinforcement has been utilized to provide reinforcement for relatively novel responses, while rigid responses would not result in reinforcement. For example, Goetz and Baer (1973) evaluated the effects of reinforcement being delivered contingent on novel forms of block building. During the reinforcement of different forms condition of the Goetz and Baer (1973) study, the researchers provided reinforcement to subjects contingent on the subjects creating diverse block forms (e.g., building with different shapes, building different constructions). However, block forms that were similar to forms already constructed during the session did not produce reinforcement. The researchers in this study discovered that variations in play behavior are susceptible to reinforcement just as variations in key pecking and button presses are in the basic literature.

Lag schedules of reinforcement. Lag schedules have been utilized to promote variability in responding across several contexts including intraverbals (Contreras & Betz 2016; Lee & Sturmey, 2006), positioning of toy blocks (Napolitano et al., 2010), and selection of novel activities (Cammilleri & Hanley, 2006; Ivy et al., 2018). The majority of research utilizing lag schedules to promote variability in children with autism has used a Lag-1 schedule in which subjects could essentially alternate between two responses to receive reinforcement. Though

some researchers (Goetz & Baer, 1973) have suggested that short-term criteria might be necessary in initially setting up contingencies to promote variability, it might be more meaningful to use larger lag schedules as a means to expand a subject's repertoire and learning history. Lag schedules can be powerful in producing variable responding, but many researchers have not observed continued variability in responding once the lag schedule was removed (e.g., Napolitano et al., 2010; Miller & Neuringer, 2000).

When using lag schedules, the majority of research has determined which items are available for reinforcement by looking at within-session data as opposed to across-session data. In within-session comparisons, variability is compared to responding in the previous trial as opposed to responding in the previous session. For example, Goetz and Baer (1973) reinforced novel block-building as long as the form of the block differed from all forms since the start of the current session (i.e., within-session). In contrast, Ivy et al. (2018) reinforced children's selection of play items so long as the selection differed from what was selected the majority of intervals from the previous two sessions (i.e., across-session). Reinforcing variability across sessions, as opposed to within-session, might increase the likelihood of sustained play, thus improving the chances for contact of reinforcement from the play items. For example, a child might need to engage with a coloring page for a prolonged period of time (i.e., to see the finished product) before contacting natural reinforcement.

Some researchers have theorized about the underlying mechanisms of lag schedules and their effects on variability. For instance, Contreras and Betz (2016) conducted a study to determine if lag schedules promote variable responding from within an established response class or if lag schedules promote generative learning in the sense that they expand a learner's response class. The researchers found that novel responses, responses that the subjects did not

have in their repertoire or had been explicitly taught, were emitted. The finding suggested that lag schedules can aid in generative learning.

Antecedent Interventions

Scripts. Scripts have been used to promote variable responding across several operants of verbal behavior including intraverbals, tacts, social commenting, and mands. Groskreutz, Groskreutz and Higbee (2015) studied the effects of script training and script-fading procedures on variable play-based commenting in children with autism. Script training consisted of scripts being attached to toys in the play areas (e.g., "I found the _____." or "Look at this _____."). Researchers in this study found that scripts evoked various comments relating to toy sets, and script fading was potentially effective in reducing subject reliance on scripts. Although script training can be useful in facilitating variable commenting, there are several prerequisite skills that a child might need to have in their repertoire before choosing this intervention (e.g., reading). Scripts also do not elicit variable selection of the initial selection of play items but only address the commenting about the particular item once it is chosen; this skill might be helpful in children who already variably select items but are rigid in their commenting.

Visual discriminative stimuli. Several studies have examined the effects of visual discrimination training procedures on promoting variability in children with autism. For example, Brodhead, Courtney, and Thaxton (2018) examined the effects of using an activity schedule to promote varied application use on an iPad® by children with autism. During baseline in this study, rigid choice of applications was observed (i.e., children chose only one app to access). The implementation of an activity schedule, in which the schedule guided subjects to choose different applications, increased the subjects' use of varied applications. However, when probes were conducted in which the activity schedule was not used, varied application use

dropped to baseline levels. Brodhead et al. (2018) studied the effects of activity schedules on selection of novel applications but did not fade the presence of the activity schedules. The authors suggested that future researchers should evaluate the effects of procedures to fade the presence of the stimuli.

Likewise, Ivy et al. (2018) used red and green placemats in addition to a lag schedule to observe the effects on variable selection of play items in children with autism. These researchers found that variability in selection responses continued after thinning the reinforcement schedule. Because Ivy et al. (2018) thinned only the reinforcement schedule and did not address that transfer of stimulus control from the visual discriminative stimuli, their subjects' variable responding could have become dependent on the presence of the placemats.

Cooper et al. (2007) discuss several methods for fading visual stimuli as a means of transfering stimulus control. For example, the authors describe removing portions of the stimuli, adjusting the shape or size of the stimuli, and superimposition of a different stimulus with simultaneous stimulus fading. For example, in several of the studies that used script training to improve variability, portions of the script were systematically faded so that stimulus control was transferred to the naturally occurring stimuli (Brodhead et al., 2016; Sellers et al., 2016). In these studies, scripts were faded one word at a time until the script was no longer present (e.g., "I want chips" faded to "I want" to "I" until the script was no longer present).

Statement of the Problem

Children with an autism diagnosis might display rigid selection of play items or play type across environments, even when it means missing out on potentially reinforcing items or activities. In addition, children that engage with a limited number of items or activities might exhibit problem behavior when in environments that do not offer access to those items (e.g., a preferred web-based application on a tablet in an area without Wi-Fi connection) or might opt-out of engaging with items that might be better suited for community involvement (Hanley et al., 2003). For example, a child who displays rigid selection of flipping through a magazine might not be as involved in the community as another child who enjoys flipping through magazines, completing group art projects and playing board games.

Based on the culmination of previous literature, there are still several areas that need to be explored within the variability research. Some of those avenues of research might be further exploring the generalization of variable responding outside of highly controlled settings as well as the fading of supports that might evoke variable responding. Regarding selection of leisure activities, it might be especially pertinent that variability generalizes so that reinforcing activities can be discovered across a wide range of environments, items and people. For example, although variability might be improved in a clinic setting, it would be helpful if variable selection of activities generalized to doctor's waiting rooms, friends' homes, and community centers.

Hanley et al. (2003) discussed rigidity in terms of limited learning history; a problem that can be addressed by behavior analysts by incorporating programmed contingencies specifically to increase that variability and expand client learning history. The purpose of this study is to identify a method to promote variable responding and to fade the intervention in a systematic fashion so that variability continues across naturalistic settings. The current research addressed

the gap in the research by using methods similar to Ivy et al. (2018) but included a larger array of leisure items, generalization probes, and systematic fading of the presence of the visual discriminative stimuli evoking variable choices.

Method

Subjects and Setting

Two subjects were selected for inclusion into the study. For inclusion, subjects were required to have either a parent or a therapist report of frequently choosing one specific activity to engage in during free time, despite there being multiple activities or items to choose from in a free-operant environment. The Rollins Institutional Review Board approved all procedures prior to the onset of the study. In addition, informed consent was acquired from a parent of each subject. The informed consent form included information regarding the purpose of the research, the methods of the research and the confidentiality of collected data.

Simon was a 7-year-old boy with an autism diagnosis. Simon had been attending a local clinic that provided behavior analytic services for two years. Simon could use full sentences to request for or label items and activities, but required prompting to engage in conversational skills. Simon typically engaged in the same type of play with specific items and would engaged in repetitive routines of play. Specifically, Simon's therapists reported that during designated free time, Simon would typically choose to engage with magnetic letters and numbers (e.g., tacting each one, lining them up to spell words) and required restricted access to preferred items to encourage variable play. For example, therapists might tell Simon that magnetic letters were unavailable and that he must choose something else.

Amanda was a 17-year-old girl with an autism diagnosis who had been attending the same behavior analytic clinic as Simon for fourteen years. Amanda emitted full sentences to request for items, but these requests often required prompts and were sometime unintelligible. Therapists reported that when denied access to her highest preferred activity (i.e., music on her phone), she did not engage with alternative leisure items without prompting. When therapists

prompted her to find something else to engage with, Amanda typically chose to play with large Lego® blocks with which she would tap on her hands or tap on her mouth.

All sessions other than generalization probe sessions were conducted in an empty therapy room (approximately 2.5 m by 2.5 m) located inside of a local behavior analytic clinic for children with developmental disabilities. The room contained laminated placemats (measuring 216 mm by 279 mm), a leisure item on top of each placemat, and nothing else. Generalization sessions were conducted in several communal play rooms of varying size throughout the clinic. Sessions were video-recorded using a camera placed on top of a tripod for data collection and interobserver agreement (IOA) purposes.

Response Measurement, Interobserver Agreement and Procedural Integrity

Responses were measured using a momentary time sampling method by dividing each 5 min session into thirty, 10 s intervals. The dependent variable (i.e., percentage of intervals engaged with items that meet the lag requirement) was calculated by dividing the total number of intervals engaged with a specific item by the total number of intervals within a session. Engaging with a leisure item was defined as being within 152 mm of the item and either handling the item or having face/body oriented toward the item. For example, watching cars go down a race track would be counted as engagement, whereas staring at the clock on the wall would not be scored as engagement. This definition did not take into account the type of play (i.e., “appropriate” versus “inappropriate” play) that the subject engaged in with the item.

Interobserver agreement (IOA) was assessed using one independent observer who collected data for 34% of all sessions and at least 30% of sessions within each condition of the study for each participant. IOA was calculated by dividing the total number of intervals that had agreement (i.e., the observers agreed that the subject was engaging with a particular item) by the

total number of intervals and multiplying by 100. Mean agreement across sessions for Simon was 99.6% (range, 96.7% to 100%) and was 99.2% (range, 96.5% to 100%) for Amanda.

Procedural integrity data were also taken by one independent observer who watched at least one video in each condition of the study (i.e., baseline, discrimination training, intervention and generalization probes) for each subject. A task analysis was created to list each step that was to be taken by the researcher throughout each condition of the study (see Appendix A). Procedural integrity data were calculated by dividing the number of steps conducted correctly by the total number of steps and multiplying by 100. Procedural integrity was at 100% for both Simon and Amanda.

Procedure

The majority of procedures implemented were similar to the method described in the study conducted on across-session variability by Ivy et al. (2018). An ABAB reversal design was used to evaluate the effects of the intervention and fading procedures. In each session, the subject was led into the center of the room in which all of the leisure items were placed so that they could easily be observed at the starting point. Placements of the items were rotated after each session to vary positioning. The researcher then delivered the instructions that corresponded to the current condition of the study. During the sessions, subjects were permitted to switch between activities at any time. During baseline, intervention, and discrimination training conditions (i.e., all but generalization probes), if the subject attempted to engage with multiple items at one time, the experimenter provided a verbal prompt to leave the items atop their designated placemats.

In all conditions excluding the generalization probes, the array of leisure items to choose from in the room were the three highest preferred items as identified in a brief multiple stimulus

without replacement (brief MSWO; Carr et al., 2000) preference assessment conducted prior to baseline in addition to three other items as identified by the principal researcher. One of the items present in the room was the item that parents and/or therapists had reported as the item most often chosen during designated free time. In addition, prior to the start of each session that the subject was eligible to earn preferred edibles (i.e., discrimination training, intervention, and stimulus fading conditions), the subject was given a choice between five edible options for the researcher to deliver in the subsequent session (Mason et al., 1989).

Baseline. In each session of the baseline condition, there were six leisure items on top of six white placemats evenly spaced around the room. After the subject was led into the center of the room, the researcher provided the instruction, "It's free time, you can play with any item and switch between the items at any time." During baseline sessions, there were no programmed consequences for engaging with any of the items, and the session concluded after 5 min had elapsed.

Discrimination Training. Discrimination training sessions were conducted to promote discriminative skills between two different colored placemats: one red placemat and one green placemat. Two identical leisure items were set on top of two evenly spaced placemats. In order to control for a potential reinforcement history being developed prior to intervention, the leisure activities selected for discrimination training differed from the items that were used during the intervention condition.

After the subject was led into the center of the room, the researcher provided the instruction, "It's free time, you can play with [item] at the green mat and get [preferred edible], or you can play with [item] at the red mat." The subject earned a small portion of preferred edible and praise immediately after choosing the item on top of the green placemat and

continued to receive the preferred edible for every 30 s spent engaging with the item atop the green mat. If at any time the subject switched from the item on top of the red placemat to the item on top of the green placemat, the subject immediately received an edible. No edibles were provided for initially choosing the item at the red mat or for subsequent time engaged with the item at the red mat. Discrimination training continued until the subjects chose the item on top of the green placement for at least 80% of intervals across three consecutive sessions and across at least two days.

Intervention. A second-order lag schedule in combination with visual discriminative stimuli was used during intervention sessions to promote variability across sessions in selection of leisure activities. In these sessions, six items were placed on six placemats that were evenly spaced around the room. Two items were placed on red mats and the other four were placed on top of green mats. The items that had red placemats under them were the items that did not meet the Lag-2 requirement. To determine the items that met the lag requirement, items that produced preferred edibles in each session were based upon the percent of intervals engaged with each item from the previous two sessions. The two items that the subject engaged with most in the previous two sessions did not produce edible reinforcement; engagement with any other item did result in the delivery of an edible. For example, if a subject spent the majority of their intervals with a dollhouse and a racecar track in the first and second session of intervention, preferred edibles would be delivered contingent on play with any item other than the dollhouse or the racecar track in the third session of intervention. However, if the subject only engaged with one item for the previous two sessions, only one item was placed on top of a red mat and the other five items were placed on top of green mats. In the first intervention session, the items that had red mats under them were the items that the subject engaged with in the largest percentage of

intervals from the final two baseline sessions. The items were rotated around the room each session so that their placement did not match the positioning from the previously conducted session.

After the subject was led to the center of the room, the researcher provided the instruction, “It’s free time, you can play with any item and switch between the items at any time.” An edible item was provided upon initial selection of any item with a green placemat and every 30 s for the remainder of time spent with items on top of a green placemat during the session. As in discrimination training sessions, no programmed consequences were provided for selection of items on top of the red placemats, and an edible and praise were immediately provided upon switching from an item on a red mat to an item on a green mat (see Appendix A for intervention flowchart).

Stimulus Fading. Procedures in this condition were identical to the procedures in the intervention sessions, but the color and presence of the red and green placemats were systematically faded in five sequential steps (see Appendix B for fading diagram). The faded placemats were created using Microsoft® Word, printed, and laminated in the same fashion as the mats used in both baseline and intervention sessions. The first stimulus fading condition contained colored mats at 50% transparency, the second condition had colored mats at 75% transparency, the third condition had mats at 95% transparency and the fourth condition had mats at 100% transparency (i.e., white mats). The fifth and final step removed the presence of the mats entirely. Throughout the fading procedures, edibles and praise continued to be delivered for engagement with items that met the Lag-2 schedule requirement, and the preferred edibles were not provided for engagement with items that did not meet the lag requirement. In order to move

from one fading condition to the next, subjects were required to engage with items that met the Lag-2 schedule requirement for 80% of intervals across three consecutive sessions.

Generalization probes. Three consecutive sessions were conducted per each generalization probe: two sessions to identify the items that meet would meet the Lag-2 requirement and one to determine percent of intervals in which the subject engaged with items that met that lag requirement. These sessions were conducted consecutively within the same day so that items present in the first session were still present in the third session. Generalization sessions were conducted in the subjects' natural play settings including several communal play rooms throughout the clinic. Various items were present around the room and varied across probes. After leading the subject into the center of the room, the researcher instructed the subject, "It's free time, you can play with any item and switch between the items at any time." No researcher-provided consequences (i.e., edibles or praise) were delivered during these sessions.

Results

Simon

Simon's preference assessment indicated that the Doodleboard toy was Simon's highest preferred item (see top panel of Figure 1). This preference was followed by both letter magnets and LeapFrog letters. All three of these items were included in the array of toys for each condition of the study (other than the generalization probes) in addition to three other items as chosen by the principal researcher.

Simon's data are displayed in Figure 2. It should be noted that for all sessions in which placemats were present, Simon chose only one item to engage with for the entire duration of the session (i.e., he never switched items within a session). During the initial baseline condition, Simon selected the same item (a Doodleboard with which he drew and tacted numbers) for four

out of the six sessions. This restricted responding is similar to what has been observed in previous research regarding variability in play skills with children with autism (Hanley et al., 2013; Ivy et al., 2018).

Simon met criteria to move on to intervention after seven sessions of discrimination training. Once the colored placemats and contingent edibles were introduced into the sessions, Simon began engaging with items other than the Doodleboard, such as Lego® blocks and Play-Doh. In contrast, during the second baseline condition (i.e., in which visual supports and edible items were not present), Simon once again only engaged with the Doodleboard toy for several consecutive sessions. Once the visual discriminative stimuli were reintroduced during the intervention condition and subsequently faded, Simon's choices in selection of play items became more variable and maintained across fading steps.

Figure 3 shows Simon's cumulative choices per play item across sessions. In sessions 1 through 18, Simon engages with only four out of the six items that are available to choose from in the session room. Conversely, for the remainder of his participation in the study, Simon began to engage with all of the items present in the room. Simon's data within generalization probes were variable. In sessions 11 and 40, Simon engaged with either an item that met the lag requirement or would engage with multiple items at one time. For example, in session 11, Simon bounced on a large ball for all three sessions of the generalization probe, but also began picking up miscellaneous toys around the playroom in his third session, thus meeting the lag requirement. However, in the generalization sessions 6 and 28, Simon either chose nothing to engage with or would switch between only two items, thus not meeting the lag requirement.

Amanda

Amanda's preference assessment indicated that, similar to her therapists' report, the large Lego® blocks were Amanda's highest preferred item (see bottom panel of Figure 1). In addition to the large Lego® blocks, Amanda's second and third highest preferred items (wooden blocks and doll bed, respectively) and three additional items were included in the array of items to choose from throughout the study.

During all five baseline sessions, Amanda only engaged with the large Lego® blocks. Before meeting criteria to move on to intervention, Amanda participated in a total of ten sessions of discrimination training sessions (see Figure 4). In addition, after several sessions without discrimination during this condition, Amanda participated in one session of forced exposure prior to the start of session 8 of discrimination training. During this forced exposure portion, Amanda was instructed to first play with the item on the green mat for one minute in which she received two edible items. Next, she was instructed to play with the item on the red mat for one minute in which no edible items were delivered. After this forced exposure to the contingencies associated with each placemat, discrimination training sessions were conducted as normal. Figure 2 displays Amanda's selection of items across both baseline and intervention. Because she did not meet criteria to reverse back to baseline, Amanda's participation in the study concluded after several consecutive sessions of invariable play. Only one generalization probe was conducted with Amanda. In this probe, Amanda selected the large Lego® blocks for each of the three sessions within the probe.

Discussion

The purpose of this study was to extend previous research regarding variability in children with autism. Although previous research has indicated that lag schedules and visual discriminative stimuli can improve variability in play skills, fewer researchers have explored the fading procedures necessary to maintain variability in the absence of the associated stimuli.

The procedures implemented in this study were effective in increasing variable play for one out of two participants. This research indicates that utilizing a lag schedule in conjunction with visual discriminative stimuli might be effective for some participants, but that there might be necessary prerequisite skills for clients to have prior to practitioners considering using this intervention. Alternatively, individuals might require different interventions to increase variability such as explicitly teaching novel responses prior to implementing a lag schedule or shaping novel responses. In addition, this study indicates that slowly fading the transparency of the color of placemats might be an effective method to transfer stimulus control to more naturalistic discriminative stimuli in a child's environment. This transfer of stimulus control is an important factor to consider so that behavior might maintain in the absence of the stimuli.

For Simon, this intervention was effective in increasing the variable selection of play items whilst in a highly controlled setting. During baseline sessions, Simon repetitively chose the same item for the majority of sessions. While intervention was in place, Simon began engaging with a larger array of toy options that were available to him. When placemats were systematically faded and subsequently removed, Simon's variability maintained. However, it cannot be concluded that this variability generalized to more naturalistic settings because of the variability of results in the generalization probes. The cumulative graph that shows Simon's cumulative choices (see Figure 3) is included as it shows that not only did Simon meet the Lag-2

requirement, but he began responding more variably than what was required to earn edible items and praise.

However, for Amanda, the intervention was ineffective at evoking variable play. Throughout each condition of the study in which she participated, Amanda only engaged with the large Lego® blocks. There are several theoretical reasons why this intervention might have been ineffective for this subject, though it cannot be concluded with certainty. First, it might be that the edible items and praise did not function as a reinforcer for Amanda. Conducting a reinforcer assessment prior to offering the pre-session choices of edibles might have been more effective in evoking different selections of items. Second, because her responding during discrimination training was highly variable (see Figure 4), it might be that a more stringent mastery criterion might have been more appropriate to confirm that discrimination between the reinforcement schedules associated with each placemat had occurred.

Although one subject engaged in variable responding without the presence of the placemats, there are some limitations that should be noted. First, although the current intervention evoked variability in the initial selection of items, the same type of play typically occurred each session. For example, when Simon selected the Doodleboard toy, regardless of which colored placemat it was atop, he engaged in the same type of play each time: writing numbers and tacting them out loud. Future researchers might consider expanding upon the current research by using lag schedules to vary the type of play associated with a single item. For Simon, this might have been done by using a lag schedule to reinforce different topographies of play with a doodleboard such as drawing pictures or spelling words.

Second, generalization of the variable play to traditional play rooms did not occur for either subject. This finding is consistent with previous research regarding the generalization of

interventions to increase variability (Napolitano et al., 2010; Ivy et al., 2018). This lack of generalization might limit the efficacy of implementing this procedure in a typical clinical setting in which the environment is less controlled than that of an experimental setting. Future researchers might consider exploring options in which lag schedules and visual supports can be faded so that responding occurs in environments other than the experimental setting. For example, researchers might consider training multiple exemplars such as conducting initial training sessions in varying rooms or varying the types of toys present throughout the study to encourage generalization to other settings and play items.

Third, the current research did not use a reinforcement schedule thinning procedure. Throughout each condition of the study (except for generalization probes), edibles and praise continued to be delivered contingent on variable responding for initial responses and the subject's subsequent continued engagement. However, previous research (e.g., Ivy et al., 2018) has indicated that thinning the schedule of reinforcement can still be successful maintaining variable responding, at least when the placemats are still present in the session. Thinning the schedule of reinforcement might be an important step to explore once the visual supports have been faded out of the intervention or vice versa.

Researchers in this area might also consider further evaluating the effects of lag schedules and visual discriminative stimuli on response variability with different types of play items. Children with autism might spend more time with electronics when compared to their typically developing peers (MacMullin, Lansky & Weiss, 2016). This restricted interest in electronic items might prevent adequate involvement in community settings; conversely, the selection of alternative items might provide more opportunities for social skills for these

children. The current study might provide practitioners and researchers a method for promoting a child's selection of items other than electronics (e.g., iPads®).

It is also unknown at which point practitioners might want to consider specifically programming for variability. Researchers might want to work toward identifying if there is a certain number of responses that might need to exist within a response class prior to requiring variability within that response class. More specifically, it would be interesting for future researchers to conduct a longer observation period to record responses that already exist within a client's repertoire to see if the number of responses effects the likelihood of a lag schedule of reinforcement being effective.

The mechanisms by which the lag schedule and inclusion of discriminative stimuli were effective for Simon are still largely unknown and should continue to be researched. Providing reinforcement for the selection of novel items might have made those different items into conditioned reinforcers for Simon. In other words, engaging with a non-preferred item might have been paired with receiving an edible item via classical conditioning. An alternative explanation might be that because of the subject's limited learning history with the other five items present in the room, once he did engage with a novel item, Simon might have contacted natural reinforcement. Future researchers might consider methods to differentiate between the two potential mechanisms and to explore other avenues into which we might expand learning history, especially for children with repetitive interests who might not be contacting a larger array of reinforcers.

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: American Psychiatric Publishing.

Brodhead, M. T., Higbee, T. S., Gerencser, K. R., & Akers, J. S. (2016). The use of a discrimination-training procedure to teach mand variability to children with autism. *Journal of Applied Behavior Analysis, 49*, 34-48. doi:10.1002/jaba.280

Brodhead, M. T., Courtney, W. T., & Thaxton, J. R. (2018). Using activity schedules to promote varied application use in children with autism. *Journal of Applied Behavior Analysis, 51*, 80-86. doi:10.1002/jaba.435

Carr, J. E., Nicolson, A. C., & Higbee, T. S. (2000). Evaluation of a brief multiple-stimulus preference assessment in a naturalistic context. *Journal of Applied Behavior Analysis*, *33*, 353–357. doi:10.1901/jaba.2000.33-353

Carroll, R. A., & Kodak, T. (2015). Using instructive feedback to increase response variability during intraverbal training for children with autism spectrum disorder. *The Analysis of Verbal Behavior*, *31*, 183–199. doi:10.1007/s40616-015-0039-x

Contreras, B. P., & Betz, A. M. (2016). Using lag schedules to strengthen the intraverbal repertoires of children with autism. *Journal of Applied Behavior Analysis, 49*, 3-16. doi:10.1002/jaba.271

Cooper, J.O., Heron, T.E., & Heward, W.L. (2007). *Applied behavior analysis* (2nd ed.). Upper Saddle River, NJ: Pearson.

Goetz, E. M., & Baer, D. M. (1973). Social control of form diversity and the emergence of new forms in children's blockbuilding. *Journal of Applied Behavior Analysis*, *6*, 209–217. doi:10.1901/jaba.1973.6-209

Groskreutz, M. P., Peters, A., Groskreutz, N. C., & Higbee, T. S. (2015). Increasing play-based commenting in children with autism spectrum disorder using a novel script-frame procedure. *Journal of Applied Behavior Analysis, 48*, 442-447. doi:10.1002/jaba.194

Hanley, G. P., Iwata, B. A., Roscoe, E. M., Thompson, R. H., & Lindberg, J. S. (2003). Response-restriction analysis: II. alteration of activity preferences. *Journal of Applied Behavior Analysis*, *36*, 59–76. doi:10.1901/jaba.2003.36-59

Heldt, J., & Schlinger, H. D., Jr. (2012). Increased variability in tacting under a lag 3 schedule of reinforcement. *Analysis of Verbal Behavior, 28*, 131-136. doi:10.1007/BF03393114

Ivy, J. W., Payne, J., & Neef, N.A. (2018). Increasing across-session variability of leisure activity selection for children with autism. *Behavior Analysis: Research and Practice.* Advance online publication. doi:10.1037/bar0000132

Lee, R., & Sturmey, P. (2006). The effects of lag schedules and preferred materials on variable responding in students with autism. *Journal of Autism and Developmental Disorders, 36*, 421–428. doi:10.1007/ s10803-006-0080-7

MacMullin, J. A., Lunsky, Y., & Weiss, J. A. (2016). Plugged in: electronics use in youth and young adults with autism spectrum disorder. *Autism*, *20*, 45-54. doi:10.1177/1362361314566047

Mason, S. A., McGee, G. G., Farmer-Dougan, V., & Risley, T. R. (1989). A practical strategy for ongoing reinforcer assessment. *Journal of Applied Behavior Analysis*, *22*, 171–179. doi:10.1901/jaba.1989.22-171

Miller, N., & Neuringer, A. (2000). Reinforcing variability in adolescents with autism. *Journal of Applied Behavior Analysis*, *33*, 151–165. doi:10.1901/jaba.2000.33-151

Mullins, M., & Rincover, A. (1985). Comparing autistic and normal children along the dimensions of reinforcement maximization, stimulus sampling, and responsiveness to extinction. *Journal of Experimental Child Psychology, 40*, 350–374. doi:10.1016/0022-0965(85)90095-5

Napolitano, D. A., Smith, T., Zarcone, J. R., Goodkin, K., & McAdam, D. B. (2010). Increasing response diversity in children with autism. *Journal of Applied Behavior Analysis*, *43*, 265–271. doi:10.1901/jaba.2010.43-265

Neuringer, A. (2002). Operant variability: Evidence, functions, and theory. *Psychonomic Bulletin & Review, 9*, 672–705. doi:10.3758/bf03196324

Page, S., & Neuringer, A. (1985). Variability Is an Operant. *Journal of Experimental Psychology: Animal Behavior Processes*, *11.* 429-452. doi:10.1037/0097-7403.11.3.429

Pryor, K. W., Haag, R., & O'reilly, J. (1969). The creative porpoise: training for novel behavior. *Journal of the experimental analysis of behavior*, *12*(4), 653–661. doi:10.1901/jeab.1969.12-653

Sellers, T. P., Kelley, K., Higbee, T. S., & Wolfe, K. (2016). Effects of simultaneous script training on use of varied mand frames by preschoolers with autism. *The Analysis of Verbal Behavior*, *32*, 15–26. doi:10.1007/s40616-015-0049-8

Wolfe, K., Slocum, T. A., & Kunnavatana, S. S. (2014). Promoting behavioral variability in individuals with autism spectrum disorders: A literature review. *Focus on Autism and Other Developmental Disabilities, 29*, 180-190. doi:10.1177/1088357614525661

FIGURES

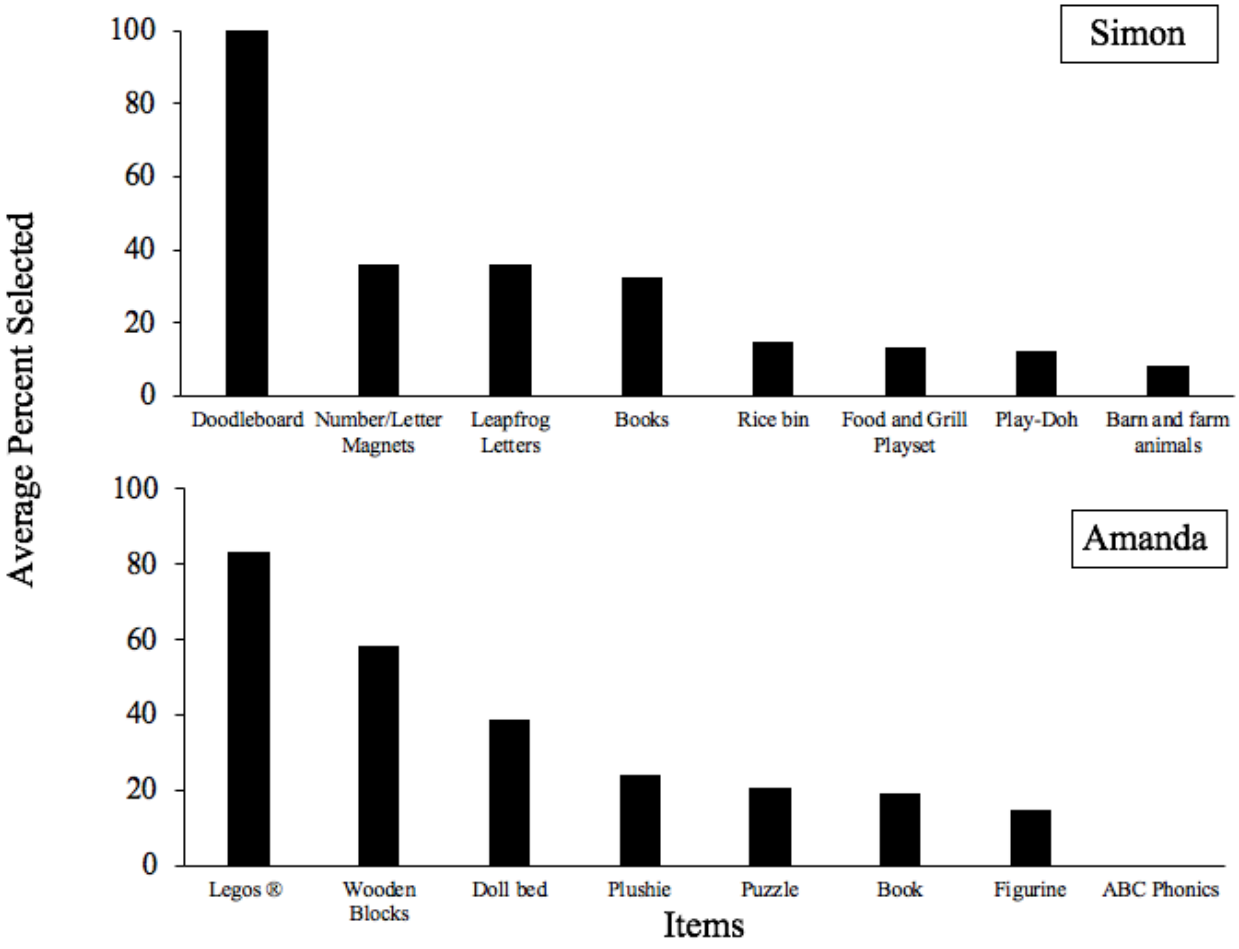


Figure 1. Results from Simon's preference assessment are indicated in the top panel, whereas results from Amanda's preference assessment are indicated in the bottom panel.

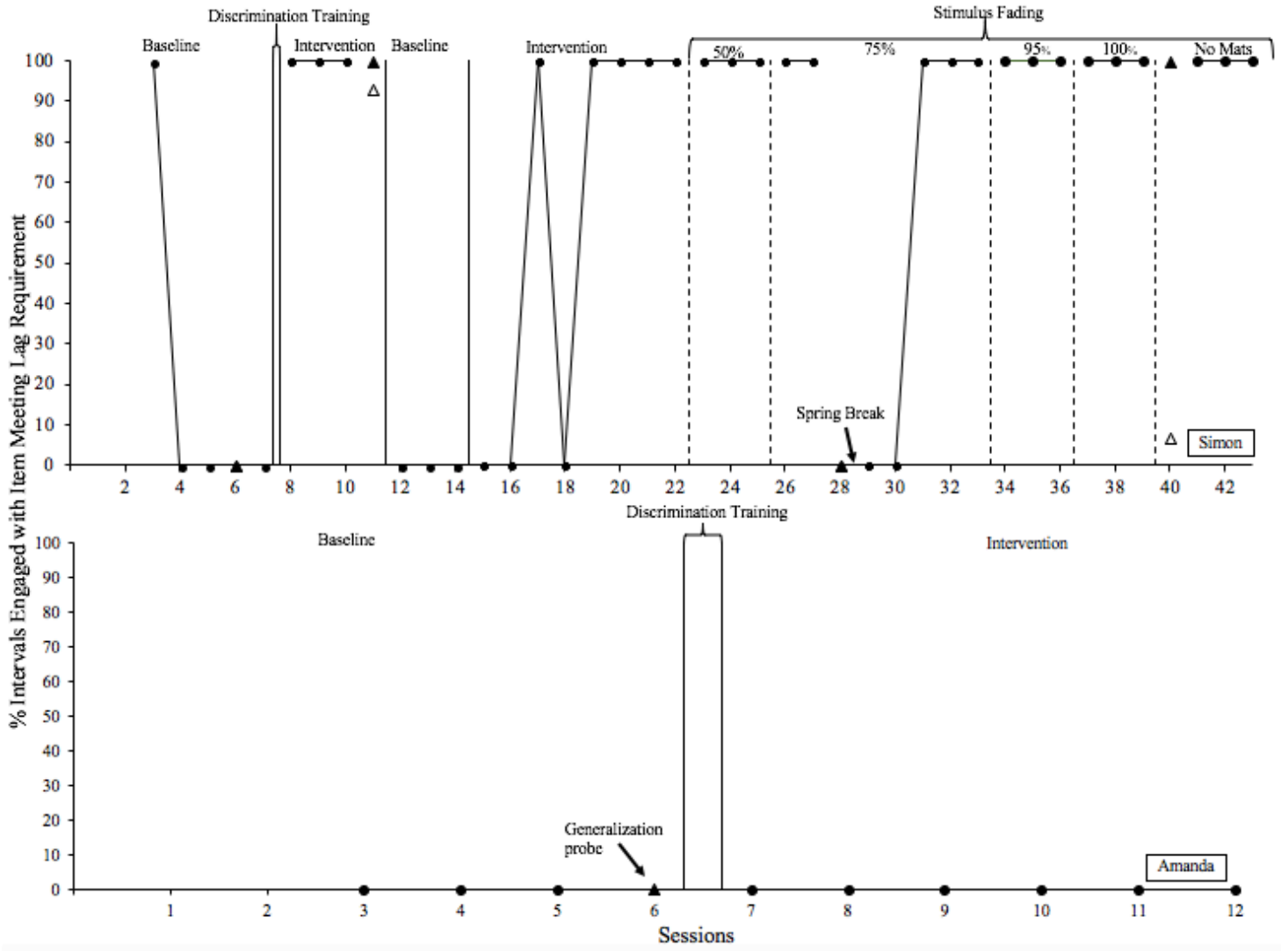


Figure 2. Simon and Amanda's percent of intervals engaged with item meeting lag requirement across phases. The first two sessions are left blank as they were used to determine which items would meet the lag requirement for subsequent sessions. Both triangles denote data from the third session of each generalization probe; open triangles denote the percent of intervals engaged with an item meeting the lag requirement, and closed triangles denote the percent of intervals engaged with an item not meeting the lag requirement (i.e., as opposed to no item). The first two sessions of each generalization probe are not graphed as they were used to determine which items would meet the lag requirement in the third session.

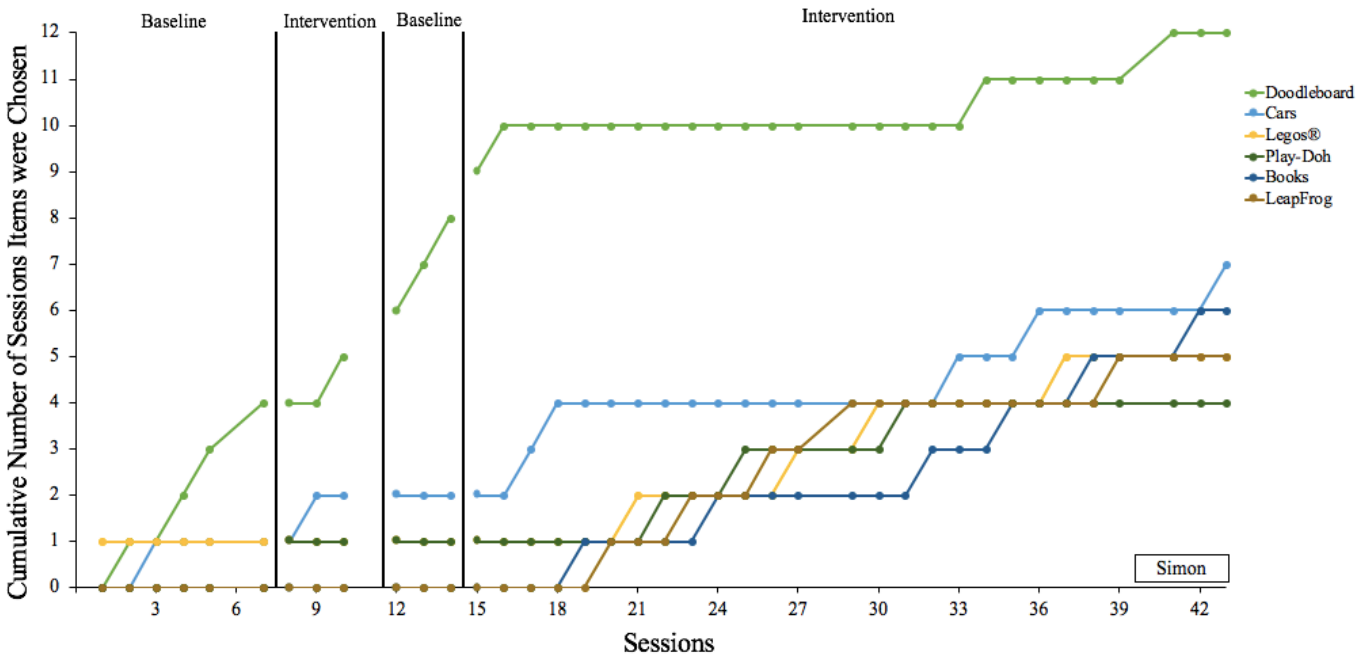


Figure 3. Simon's cumulative number of choices per each item across sessions. Generalization probe data were removed from this graph as the toy choices in other conditions of the study were not available in the probes.

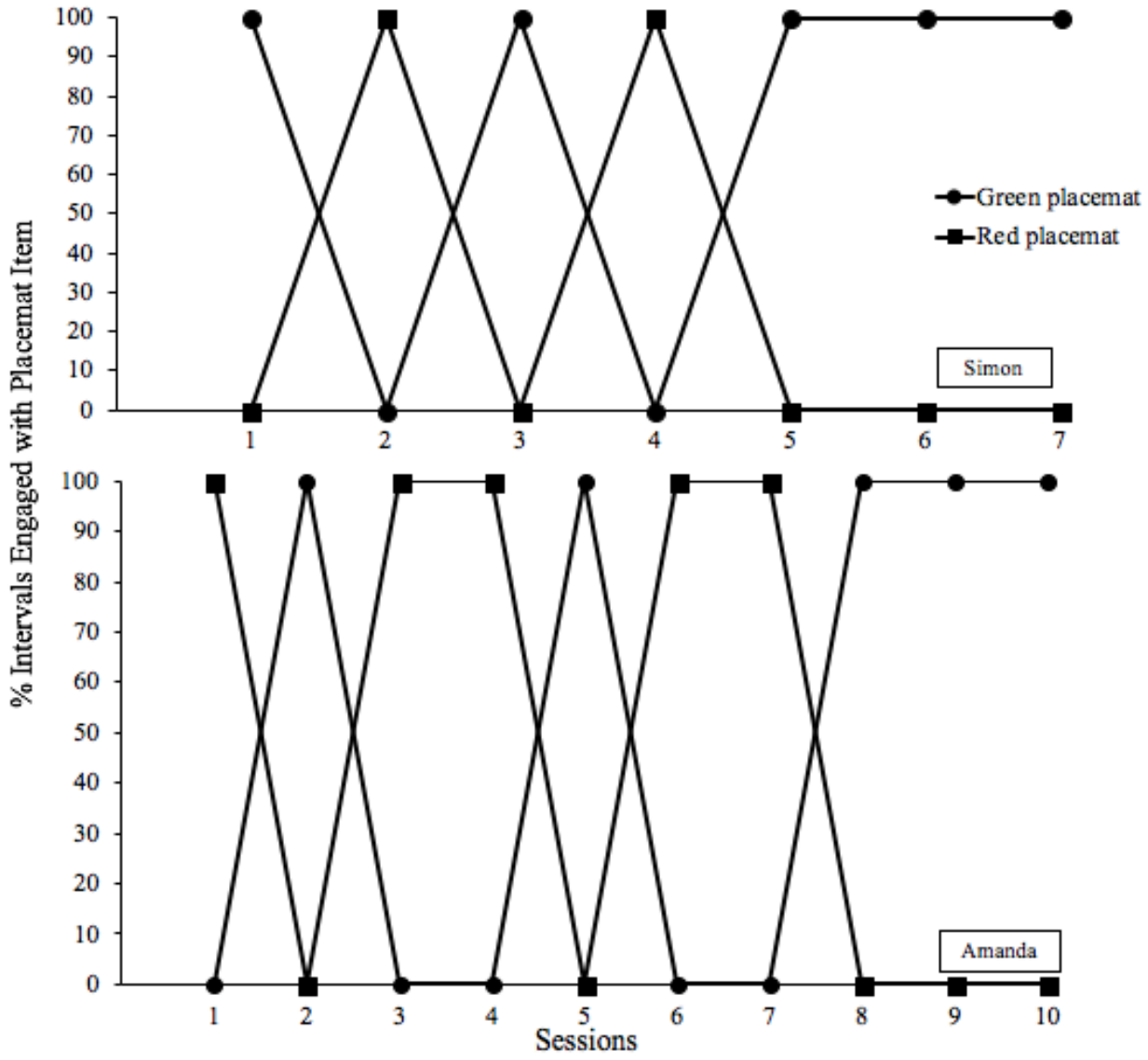


Figure 4. Number of discrimination training sessions before moving to the intervention condition for Simon and Amanda. Amanda experienced an added "forced exposure" component immediately prior to the start of session 8.

APPENDIX A: TREATMENT INTEGRITY CHECKLIST

Treatment Integrity Data Sheet

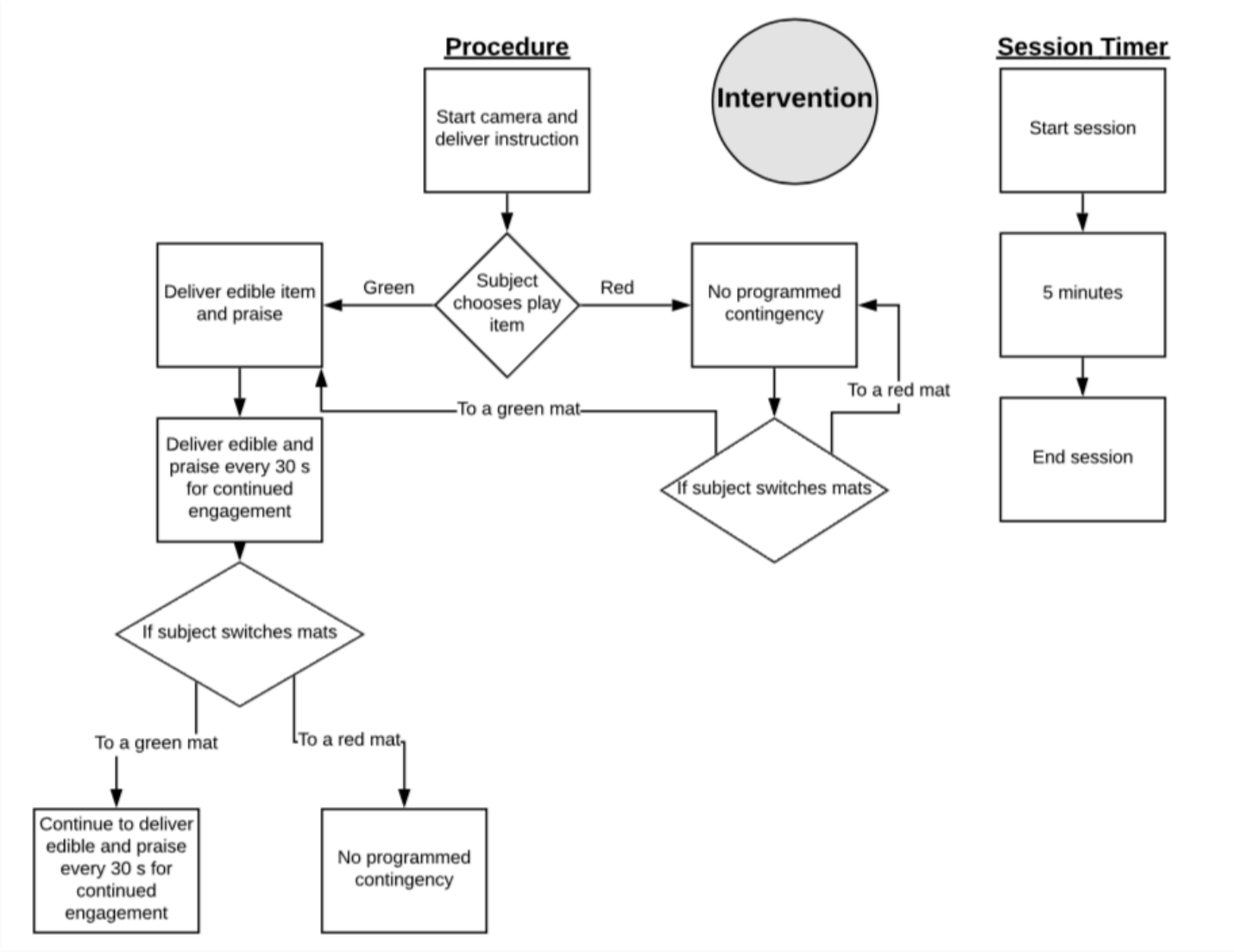
Project: _____

Subject: _____ Data Collector: _____

Score a (+) if the step was done correctly, a (-) if the step was done incorrectly or was incomplete, and a (n/a) if the step was unnecessary or did not apply to current condition.

	S#: Con: Baseline	S#: Con: Discrimination	S#: Con: Intervention	S#: Con: Generalization
Session was set up according to design (i.e., BL= 6 white mats with a toy on top of each, INT= 6 different colored mats, DT = 2 mats with identical item, GP = no mats)				
Placemats were rotated around the room so that they did not match the placemats from the previous session				
Researcher presented correct instruction corresponding with the current condition.				
Upon initial selection of green mat, researcher delivered edible and praise.				
Upon initial selection of red mat, researcher did not deliver edible or praise.				
Upon continued engagement with item at green mat, edibles and praise continued to be delivered every 25s-35s				
Upon a switch from a red mat to a green mat, edibles and praise were immediately delivered.				
Upon a switch from a green mat to a red mat, edibles and praise stopped being delivered.				

APPENDIX B: INTERVENTION FLOWCHART



APPENDIX C: STIMULUS FADING DIAGRAM