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# A PREFERENCE ANALYSIS OF REINFORCER VARIATION, SEQUENCE, AND CHOICE

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Degree of Doctor of Philosophy

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Abstract

Reinforcement procedures are the cornerstone of behavioral interventions. Previous research has demonstrated that reinforcers that are relatively more immediate, more frequent, of higher quality, and larger are more efficacious in changing behavior and are preferred to those that are relatively delayed, less frequent, of lower quality, and smaller. Reinforcer variation, sequence, and choice are parameters of reinforcement programs that have not been as thoroughly studied, but may prove to be relevant parameters of reinforcement. The purpose of this study is to examine the preference for these parameters of positive reinforcement with young children with and without developmental disabilities during academic tasks.

Keywords: choice, fixed sequence, parameters of reinforcement, preference, positive reinforcement, reinforcer variability, varied sequence

# A Preference Analysis of Reinforcer Variation, Sequence, and Choice

Reinforcement is the central feature of most behavioral interventions. Having a thorough understanding of parameters of positive reinforcement may lead to more efficacious and preferred reinforcement programs. The parameters of reinforcement that are most commonly researched and manipulated in practice are reinforcer immediacy, rate, quality, and magnitude (Hanley & Tiger, 2010; Lattal, 2013; Piazza, Roane, & Karsten, 2010).

These parameters have been shown to influence response allocation among concurrently available options. The allocation of responses to different reinforcement conditions allows the relative preference for these conditions to be evaluated. These parameters have been evaluated in translational research (Neef, Bicard, & Endo, 2001; Neef & Lutz, 2001; Neef, Mace, & Shade, 1993; Neef, Mace, Shea, & Shade, 1992; Neef, Shade, & Miller, 1994) and have also been studied in the context of socially meaningful behavior including functional communication (Athens & Volmer, 2010; Vollmer, Borrero, Lalli, & Daniel, 1999), play skills (Hoch, McComas, Johnson, Faranda, & Guenther 2002), and independent work completion (Wine & Wilder, 2009). Across some of these studies, there appears to have been individual differences in the parameter to which a participant's responding is more sensitive (Hoch et al. 2002; Neef et al., 2001; Neef & Lutz, 2001; Neef et al., 1993; Neef et al., 1992; Neef et al., 1994). For example, in Neef and Lutz, responding of different participants was primarily sensitive to rate, quality, or immediacy.

The use of preferred teaching contexts may lead to a decrease in attempts to escape through problem behavior or may minimize attempts at counter control, as discussed by Carey and Bourbon (2004) and Miller (1991). Dunlap et al. (1994) and Powell and Nelson (1997)

showed that a choice of academic tasks could lead to decreases in disruptive behavior and increases in on-task behavior. Assessing preference for reinforcement conditions in an empirical manner is also a means to evaluate the social validity of behavior-change programming (Hanley, 2010), leading to a behavior-change technology that is not only effective but also preferred by its recipients.

Previous research has shown that concurrent-chains arrangements can be effective in assessing an individual's preference for a variety of contexts (Hanley, Piazza, Fisher, Contrucci, & Maglieri, 1997; Luczynski & Hanley, 2009; Luczynski & Hanley, 2010). Many studies evaluating children's preference for reinforcement parameters rely on concurrent-chains arrangements (Schmidt, Hanley, & Layer, 2007; Tiger, Hanley & Hernandez, 2006), whereas, other studies have used concurrent-operants arrangements to assess preference for reinforcement parameters (Bowman, Piazza, Fisher, Hagopian & Kogan, 1997; Thompson, Fisher, & Contrucci, 1998). Concurrent-chains arrangements may be more suitable because terminal-link responding, which comes under the control of the parameters of the schedule or condition experience, is separated from participants responding in the initial-links, which is indicative of their preference for the experiences in the terminal links (i.e., Catania & Sagvolden, 1980). In concurrently available schedules, response allocation may or may not indicate preference for a condition; it is possible that the relative rate of behavior simply conforms to the concurrent reinforcement schedules in place. In other words, concurrent-chains schedules effectively separate responding for the various reinforcement schedules (the preference indices) from responding generated by those schedules. The two are often conflated, and thus may be confounded, in concurrent-operants arrangements.

Evaluating preference for parameters other than amount, delay, rate, and quality of

reinforcement may contribute to a more discriminated application of reinforcement procedures. Some other reinforcement parameters include the variability, sequences of delivery, and choice of reinforcers.

The efficacy of and preference for varied versus constant reinforcers has been examined in a few studies. This parameter is important to understand, as there is often a reliance on a single highly preferred item in reinforcement programs (Charlop- Christy, Carpenter, Le, LeBlanc, & Kellet, 2002; Sundberg & Partington, 1988). Early basic research by Egel (1980) conducted with children with developmental disabilities showed that varied edible reinforcer delivery yielded higher rates of lever pressing than delivering the same edible reinforcer. In a subsequent application, Egel (1981) examined the efficacy of varied and constant edible reinforcer delivery to maintain response accuracy and on-task behavior during a receptive identification task, a learning objective that was part of the participant's Individualized Education Plan (IEP). Egel (1981) found that response accuracy and on-task behavior maintained at higher rates during varied reinforcer conditions compared to a condition in which each reinforcer was singularly presented across a session. The relative preference of these reinforcers was not assessed via a preference analysis prior to these studies. Therefore, it is unclear if a higher rate of responding would maintain in the varied reinforcer condition if it were compared to a condition in which a highly preferred item were delivered exclusively. The answer to this question has direct implications for practice, as does the extent to which children would prefer a single high preference item versus varied reinforcers including the same high preference item.

Bowman et al. (1997) extended Egel's (1980; 1981) work by comparing the effects of varied and constant reinforcer delivery using a concurrent-operants arrangement. Contingent on a response of stuffing envelopes, switch pressing, or sitting or standing in a designated area, edible

reinforcers were delivered. In the constant reinforcer condition, engaging in the response resulted in delivery of the highest ranked item from a paired-item preference analysis (Fisher et al., 1992). In the varied reinforcer condition, engaging in the response resulted in delivery of the items ranked second, third, and fourth from the preference analysis in a random order. Bowman et al. (1997) showed that four participants engaged in the responses that resulted in varied reinforcement, two participants engaged in the response that resulted in constant reinforcement, and one participant allocated responses to both conditions. Both the participant who showed no preference and the one participant who responded somewhat more towards constant reinforcement conditions allocated responses to both the constant highly preferred (HP) item, as well as the three items in the varied condition in single sessions. This pattern of responding may not be an indication of indifference. It is possible that these participants switched responding across reinforcement conditions to access all four edible items in one session because the HP item was available only in the constant condition. In these instances, it is unclear if the difference in responding between constant and varied reinforcer conditions was a result of the relative preference for all items or the variation of reinforcers across options.

Preference for a varied reinforcer condition *that includes the HP item* has yet to be evaluated relative to a constant HP reinforcer condition targeting academic tasks in a concurrent chains-arrangement (Catania, 2012; Hanley et al., 1997). This preparation would allow for initial-link responses to access the different reinforcement contingencies to be isolated from the effects of the different reinforcement contingencies on academic responses.

It is possible that the variation of reinforcers is preferred to constant reinforcement because satiation to a particular reinforcer (Vollmer & Iwata, 1991) is less likely to occur when reinforcers are varied. This may be a reason why choice of reinforcers may also be preferred

(Fisher, Thompson, Piazza, Crosland, & Gotjen, 1996). Fisher et al. (1996) demonstrated that children allocated more responding to choice conditions in which they chose from an array of two HP items (e.g., television, hugs, Nintendo games, orange slices, chips, and games) or two LP items (e.g., pizza, books, beads, and clapping) compared to a condition in which the experimenter delivered the same reinforcers on a yoked schedule. One downside of the yoking schedule in the Fisher et al. study is that there may be momentary differences in the value of a reinforcer, which may influence which reinforcer was chosen when given the chance.

Expanding on Fisher et al. (1997), Tiger et al. (2006) examined the preference for choice making with children using a concurrent-chains arrangement in a manner that controlled for the potential differences in quality across choice and no-choice conditions, as well as the potential changes in momentary satiation and deprivation of reinforcers. Participants first chose a worksheet in the initial-link, following the selection, the child completed academic problems on the worksheet. Contingent on completing academic tasks (i.e., pointing to letters, numbers, and shapes) participants had the option to choose from an array of identical reinforcers (i.e., red M&M's) in the choice condition, while the experimenter delivered an identical single reinforcer in the no-choice conditions. In other words, the reinforcer was the same for each response; the only difference between the conditions was the arrangement of reinforcement delivery. Children preferred choice conditions relative to no-choice conditions, even as the number of correct responses on academic tasks required to obtain reinforcement increased. To control for the illusion of a larger magnitude of reinforcement (of having multiple items) only in the choice condition, Schmidt et al. (2009) evaluated the preference for choice and no-choice conditions with an identical array of high preference edible items as well as of low preference items such as blank stickers. The opportunity to choose reinforcers was preferred for children when they could

choose from high-preference items or from low-preference items These studies suggest that the opportunity to choose itself can be a reinforcer. In other words, the relative value of the items chosen was not responsible for children's preference for conditions involving choice.

Choice of reinforcers is a parameter of reinforcement that has also been shown to affect response allocation more than rate of reinforcement, with individuals allocating more responses to conditions in which they can choose reinforcers relative to those with a higher rate of reinforcement (Thompson et al., 1998, Tiger et al., 2005). In the analysis by Thompson et al., a 4-year-old boy diagnosed with pervasive developmental disorder received the same amount of soda across conditions; however, he preferred the condition in which he was allowed to choose what cup and if a straw was used, compared to the therapist choice condition. The authors continued to reduce the rate of reinforcement in the choice condition via a VI-600 schedule, compared to the VI-15 schedule in the no choice condition. These findings differ slightly from an evaluation by Fisher et al. (1996) in which participants allocated more switch presses to a therapist choice condition in which high preference items were delivered, relative to the choice condition in which low preference items were delivered. The participant previously allocated more responses to the choice condition, however, when the quality of reinforcers was higher for the experimenter choice condition, the participants allocated more responding to the no-choice condition. This suggests that choice of reinforcers may eclipse some parameters of reinforcement (i.e. the rate of reinforcement; Thompson et al.; Tiger et al.), while sometimes being overshadowed by other parameters (i.e. quality of reinforcement; Fisher et al.).

In addition to the variation of reinforcers that choice arrangements can offer, one reason that there may be a preference for choice of reinforcement is that participants are able to control the delivery of the reinforcers and thus predict which reinforcer will be next. In previous research

on variation of reinforcers, the reinforcers were delivered in a random order (Egel, 1980; Egel, 1981; Bowman et al., 1997). One parameter that is worth evaluating is the preference for the order predictability of reinforcer delivery. Assessing the preference for a fixed or varied sequence of reinforcer delivery following a demonstrated preference for variation may assist teachers in determining how to arrange varied reinforcer delivery. In addition, previous research has demonstrated that children allocate more responses to conditions in which there is the opportunity to choose reinforcers when there is an array of high quality items (Fisher et al., 1996); however, preference for choice relative to a preferred fixed or varied sequence of high preference reinforcers is not known.

The purpose of this study is to examine the preference for several parameters of reinforcement including variability, sequence, and choice of reinforcers. In all studies, each reinforcement condition was first assessed in a single-operant arrangement to (a) determine if the condition served as reinforcement for academic responses, and (b) to correlate the reinforcement parameters to arbitrary stimuli for use as initial-link cues in subsequent concurrent chains analyses. Preference was assessed in a concurrent-chains arrangement to isolate preference indices from the direct effects of the reinforcement parameters. The order of the studies was arranged so an individual's preference from an earlier evaluation would inform subsequent evaluations. This sequential approach serves as a model for assessing preference for reinforcement parameters in practice.

## General Method

### Participants, Setting, and Materials

Ten children, ages 5 through 11, participated in the study. Jesse, Jenny, and Alex were enrolled in a special education pullout classroom for children performing below grade level. Max

was diagnosed with autism and enrolled in a special education classroom for children diagnosed with autism. Sessions took place in a separate area of the classroom. Alice, Mary, Tara, Zack, Jane, and Lisa were typically developing children enrolled in a general education kindergarten classroom. Sessions took place in either a separate small room in the school, or separate area of the classroom. Session areas included a table, chairs, and materials for the academic tasks.

The student previously mastered the tasks chosen, but teachers identified a need for continued practice. Jesse, Jenny, and Alex had different academic tasks for each of the studies. For example, Jesse started with adding a single-integer number to a double-integer number (Study 1), then adding two double-integer numbers (Study 2), followed by either subtraction or addition of a single-integer from a double-integer number (Study 3). Max, Alice, Mary, Tara, Zack, Jane, and Lisa all had the same task across the three studies. See Table 1 for setting, tasks, and materials specific to each participant.

**Paired-Item Preference Analysis**

Participant preferences were assessed for 10 items using a paired-item preference analysis consistent with Fisher et al. (1992) prior to the start of each comparison. The 10 items were identified from teacher reports of the reinforcer types they would be willing to incorporate in their classrooms. Jesse, Jenny, Alex and Max all chose from an array of edible items. Alice, Mary, Tara, Zack, Jane, and Lisa all chose from an array of stickers to place on colorful paper. See Table 2 for a list of specific reinforcers used across each study.

**Reinforcement Sensitivity Test**

Prior to the start of evaluations, all participants were exposed to a condition in which academic responses were reinforced on an fixed ratio (FR) 1 schedule with the item identified as most preferred via the paired-item preference analysis and one in which academic responses

received no differential consequence. The preparation for this pretest was consistent with the general methods. Fourteen potential participants were exposed to these conditions, ten continued in the study following a demonstration that the edible items or stickers served as reinforcers for the chosen academic responses and in the context of an alternative activity (doodling with pencil and paper), and the condition in which reinforcers were delivered was preferred (data available upon request).

**Exposure Sessions**

After the identification of highly preferred edible items or stickers, participants were exposed to conditions to assess if the preferred items functioned as reinforcers given the different changes to the parameters and to correlate arbitrary stimuli with reinforcement contexts. Reinforcement and extinction sessions were rapidly alternated, and the order they were presented was randomized and counterbalanced. In the reinforcement and extinction conditions, items for an academic task (e.g. a math problem or writing) were present, as well as materials for an alternative activity (e.g. drawing on a scrap piece of paper). Materials were present for an alternative activity to emulate ecologically valid teaching conditions in which there would be alternative sources of reinforcement or activities (i.e. a break from academics or engaging in a preferred activity) available.

In reinforcement conditions, accurate responses were reinforced on an FR 1 schedule with high preference items. In each comparison, only one parameter was manipulated. In the control condition (extinction), completing the task did not result in the presentation of a reinforcer. A laminated Wingdings symbol was correlated with each condition and placed in the child's visual field during all sessions. The participant was initially shown the Wingdings symbol and the condition was described to the participant (i.e. "When this picture is on the table, if you

write a letter and it's correct you will receive a sticker, or you can draw at anytime" or "When this picture is on the table, if you write a letter, even if it's correct you will not get a sticker, or you can draw at anytime"). These symbols were later used as initial-link stimuli in the preference evaluation.

During the exposure sessions, attention was delivered on a fixed time (FT) 1 min schedule; attention was not response specific (e.g., "I like your shirt" and "What a nice day"). Bids for attention by the participant also resulted in attention from the experimenter. Sessions were terminated following 20 responses or 3 min, whichever occurred first.

**Preference Evaluation**

Preference evaluation sessions were conducted following the exposure sessions and involved a concurrent-chains arrangement. Laminated Wingdings symbols that were previously presented in the exposure sessions were placed on the table in front of the participant and served as initial-link stimuli signaling the different conditions operating in the terminal links. The location of the Wingding symbols was randomized across sessions. At the beginning of each session, the experimenter prompted the participant to pick a condition by saying "pick one." Choosing a symbol resulted in immediate praise (e.g., ''Nice job picking one") and all other symbols were removed from the table. The experimenter then put the materials for the participant on the table and provided access to the terminal link in which the participant experienced the condition correlated with the Wingdings symbol.

During the preference evaluation, the terminal links were identical to the conditions in the exposure sessions. Preference was demonstrated when one condition was selected four more times than any other conditions (Luczynski & Hanley, 2009; Luczynski & Hanley, 2010). The preference evaluation was stopped if preference was not demonstrated within 12 sessions.

**Data Collection and Interobserver Agreement.**

Two trained observers independently recorded the number of completed academic tasks during sessions, which were defined as the individual independently completing the specified task correctly (See Table 1 for specific responses for each participant). All sessions were videotaped. Rate of correct academic responses was calculated by dividing the number of responses by the session duration (either 3 min or the time in which the participant completed 20 responses) whichever occurred first. In our analysis, we did not remove the consumption of reinforcers (the reinforcement time) from the overall session time. This decision was made because reinforcer consumption time was very brief (i.e., did not affect rates of academic responding) and because participants could and often did engage in the academic responses while either eating or placing the sticker on the sheet. A trained observer also independently recorded selection of Wingdings symbols as well as the number of completed academic tasks during preference evaluation sessions. Selection of a Wingdings symbol was defined as the participant touching the symbol.

Interobserver agreement (IOA) data were collected on an average of 48% of exposure sessions (range, 37% to 60% across participants). IOA for exposure sessions was an average of 99% (range, 98% to 100% across participants). IOA was collected for an average of 45% of preference evaluation sessions (range, 33% to 55%). IOA for preference evaluations was 100%. IOA was calculated by dividing the number of agreements during each session by the agreements plus disagreements for the entire session and multiplying by 100%. An agreement was defined as both observers recording the completion of the academic response, while a disagreement was defined as one observer recording the completion of an academic response while the other observer did not.

## Study 1: Constant versus Varied Reinforcer Delivery

In Study 1 we evaluated the preference for variation of reinforcement, expanding on previous research (Bowman et al., 1997; Egel, 1980; 1981) by identifying a preference hierarchy, including the high preference item in both the constant and varied reinforcement conditions, and evaluating the effects of reinforcer variation on academic responses in both typically developing children and those in special education classrooms.

### Exposure Sessions

In the constant reinforcer condition, the item ranked first from the paired-item preference analysis was delivered. In the varied reinforcer condition, either the first, second, or third ranked item from the paired-item preference analysis was randomly delivered. In the control condition (extinction), completing the task did not result in the presentation of a reinforcer. Prior to the start of the session, the participant was shown the Wingdings symbol and the condition was described (i.e. “When this picture is on the table, when you write a letter correctly you will receive a princess sticker” or “when this picture is on the table, when you write a letter correctly you will receive either a princess, Hello Kitty, or My Little Pony sticker”). This evaluation was consistent with the general methods described previously.

### Preference Evaluation

Preference was assessed as described previously in a concurrent-chains arrangement. Wingdings symbols that were correlated with the constant reinforcer condition, varied reinforcer condition, and extinction condition were placed on the table and the participant was prompted to select one.

### Results and Discussion

Constant and varied reinforcer delivery resulted in similar rates of academic responding

that were higher relative to extinction conditions for all participants during the exposure sessions (see left columns of Figure 1 and top panel of Figure 4). The highest mean rate of responding in the constant reinforcement condition was 11.7 in Jenny's evaluation. Alex had a mean rate of academic response of 10.6, which was the highest mean rate in the varied reinforcer condition. The only participants who responded in the extinction condition were Max, Jane, and Lisa. Mean rate of academic responding in the constant reinforcer condition for all participants was 7.1, 6.7 in the varied reinforcer condition, and 1.7 in extinction conditions (see top panel of Figure 4).

Seven of the 10 participants (Jesse, Jenny, Alice, Mary, Tara, Zack, and Jane) preferred varied reinforcer delivery (see right columns of Figure 1). Jesse, Jenny, Alice, Mary, and Tara, all exclusively chose the varied reinforcer condition in the concurrent-chains arrangement. Alex demonstrated indifference between the reinforcer conditions, alternating between the constant reinforcer condition and the varied reinforcer condition in the preference evaluation. Max preferred constant reinforcer delivery. Lisa had undifferentiated responding in the preference evaluation and alternated choices between the constant reinforcer condition and the extinction condition.

A majority of children preferred varied reinforcer delivery relative to constant reinforcer delivery (see bottom panel of Figure 4). This is consistent with Bowman et al. (1997) in which showed participants allocated more responses to the conditions in which one of three items were delivered contingent on correct responses in a concurrent-operants arrangement.

One participant, Max, preferred constant reinforcer delivery. This too is consistent with Bowman et al. (1997), who had two participants demonstrate a preference for the constant reinforcer condition. It is possible that the item in the constant reinforcer condition was of much higher quality compared to the second and third ranked item, which may have driven preference

towards the constant condition. A preference for constant reinforcer delivery may also be common for individuals with restricted interests (Stocco, Thompson & Rodriguez, 2011).

Two participants did not demonstrate a preference for a particular reinforcement condition. Alex chose both reinforcement conditions in the concurrent-chains arrangement. This suggests a preference for receiving edible reinforcers compared to the extinction condition, but indifference toward varied or constant reinforcement conditions. By contrast, Lisa alternated selections between extinction conditions and constant reinforcer conditions. When Lisa chose the extinction conditions, she would spend the time engaging in the alternative activity of drawing on the plain paper. The only programmed difference between the reinforcement and extinction conditions was the presence of the reinforcers and the reinforcement contingency. It is possible that the presence of the reinforcing items became a discriminative stimulus for work to be completed in the reinforcement conditions, and the removal of the reinforcers in the extinction condition could have signaled that work was not required, and this was an appropriate time to color. Participants could have also been responding to self-imposed rules based on the presence of reinforcers across conditions.

This study extended previous research by controlling for differences in quality by having the HP item in both the constant and varied reinforcer conditions. This study also expanded on previous research by having children complete academic tasks as opposed to simple operants in an analogue setting (Egel, 1980; Bowman et al., 1997). Additionally, preference for these conditions was assessed in a concurrent-chains arrangement, which better isolates preference indices.

In sum, most participants preferred the varied reinforcer condition compared to the constant reinforcer condition (see bottom panel of Figure 4). Based on these data, behavior

analysts should reconsider relying on a high preference item as the sole reinforcer in behavioral programming; variation of a few highly preferred reinforcers appears to be generally preferred.

Varied reinforcer delivery also has the added advantage of possibly preventing satiation of these potent reinforcers, as reinforcement programs are in place for a longer period of time (Vollmer & Iwata, 1991). Because our sessions were relatively short in duration and the number of sessions each participant experienced was few, we did not observe satiation effects. However, in Egel (1981), rates of responding were initially similar in constant and varied reinforcer conditions; however, as sessions continued, there was a decrease in responding in the single reinforcer condition, whereas varied reinforcement conditions maintained rates at a higher level for more sessions.

## Study 2: Varied versus Fixed Sequence Delivery

Study 2 evaluated the preference for a varied sequence of reinforcer delivery, compared to a fixed sequence of reinforcer delivery following a demonstration of a preference for varied reinforcers. Preference for the order of reinforcers has not been evaluated in children who have demonstrated a preference for varied reinforcement on completing academic responses, or the preference for this parameter relative to others. The seven participants from Study 1 who demonstrated a preference for varied reinforcers continued to Study 2.

### Exposure Sessions

In both reinforcement conditions, items ranked first, second, and third on a paired item preference analysis were delivered contingent on correct responses on an FR 1 schedule. In both reinforcer conditions, the items were visible to the participant, but were not in the specified delivery order. In the fixed sequence condition, reinforcers were delivered in the same order throughout the session (i.e., first item, second item, third item, first item, second item, third item,

etc.). In the varied sequence condition, the first, second, or third ranked item from the paired-item preference analysis was delivered in a random order (i.e., first item, third item, first item, second item, third item, second item). The varied sequence condition was identical to the varied reinforcer condition from Study 1. In the control condition (extinction), completing the task did not result in the presentation of a reinforcer.

Prior to the start of the session, the participant was shown the correlated Wingdings symbol and a summary statement of the condition was provided (i.e. "When this picture is on the table, and you answer correctly, you will receive one of these candies, but you won't know which one it will be in advance" or "when this picture is on the table, and you answer correctly, you will receive one of these candies, it will always be in the order of starburst, skittle, then a fruit snack"). This evaluation was consistent with the general methods described previously.

**Preference Evaluation**

Preference evaluation sessions were conducted following the exposure sessions. Wingdings symbols that were previously correlated with the varied sequence, fixed sequence, and extinction conditions in the exposure sessions were placed on the table. Participants were prompted to pick a Wingdings symbol in the initial-link trial as described previously, followed by access to the terminal link which were identical to those experienced in the exposure sessions.

**Results and Discussion**

Varied and fixed sequence conditions resulted in similar rates of responding with both being higher relative to extinction conditions for Jesse, Jenny, Alice, Tara, Zack, and Jane (see left column of Figure 2). Mary had a slightly higher rate of academic responses in the fixed sequence condition (*M*=8.1), relative to the varied sequence condition (*M*=6.3). The highest mean rates of academic responses in the fixed sequence (*M*=9.4) and varied sequence condition

(*M*=9.2) were in Jenny's evaluation. The only participant who responded in the extinction condition was Jesse with a mean rate of 0.2 academic responses (see left column of Figure 2). Mean rate of academic responding in the fixed sequence condition for all participants was 6.0, a mean rate of 5.5 academic responses in the varied sequence condition, and a mean rate of 0.03 academic responses in extinction conditions (see top panel of Figure 4).

Jesse, Mary, Tara, Zack, and Jane demonstrated a preference for the fixed sequence condition, whereas Jenny and Alice demonstrated a preference for the varied sequence (see right column of Figure 2). Mary chose the fixed sequence condition exclusively in the concurrent-chains arrangement. Jenny and Alice both chose the varied sequence condition exclusively in the concurrent-chains arrangement. Similarly to Study 1, preference for a reinforcer condition was not necessarily indicative of differences in the response rates in the exposure sessions (Figure 4).

Preference for the presentation order of varied reinforcers has not been evaluated previously. In previous research on varied reinforcer delivery, the order of reinforcers was randomized (Egel, 1980; Egel, 1981, Bowman et al., 1997), similar to the varied sequence condition. In our study, most children preferred receiving reinforcers in a fixed sequence. It is possible that preference for the fixed sequence of reinforcers was a function of consistently receiving the high preference item sooner in the fixed sequence relative to the varied sequence condition in which the high preference reinforcer was usually available first on only one-third of deliveries. In other words, the delays to the high preference reinforcer in the varied sequence condition may have resulted in a preference towards the fixed sequence condition in which high preference reinforcers were always delivered first on every three trials. Table 3 shows the probability that the HP item was delivered on the first trial in the exposure sessions. This was calculated by counting the number of times the HP item was delivered first, and dividing it by

the number of times any of the three item were delivered first. It is evident from these data that the overall delay to the HP reinforcer favored the fixed sequence condition; this delay reduction could have contributed to the majority of children preferring the fixed order condition (see Neef et al., 2001; Neef & Lutz, 2001; Neef et al., 1993; Neef et al., 1992; Neef et al., 1994 for demonstrations of preference for immediate reinforcement delivery compared to delayed reinforcers). It appears however those delays to the HP reinforcer were not influencing responding in the constant versus varied evaluation, because children generally preferred the varied condition despite the overall longer delays to HP reinforcers (see Table 3). Thus, it appears that the preference for the sequence of reinforcer delivery is not merely a preference for immediate delivery of a HP reinforcer.

Another factor that may influence a preference for the fixed sequence condition may be the amount of each reinforcer that was delivered. Since the HP item was always delivered first in a block of 3 trials in the session, there are some instances in which there was slightly more HP items being delivered in the fixed sequence relative to the varied sequence (see Table 4). Preference for a condition appeared to be independent of these rate effects, suggesting once again that preference for a particular sequence of reinforcer delivery cannot be attributed to differences in the rate the HP item was delivered.

A preference for a fixed sequence of reinforcer delivery may also be due to a preference for the signaled delay to reinforcer delivery. Before each session, the contingency was described to the child. In the fixed sequence condition, these instructions that included the order may have acted as a signal of when each item was being delivered. During the session, an obtained reinforcer may have signaled the delivery of the subsequent reinforcer. Previous research has shown that there is a preference for a signal regarding delays to reinforcement (Lattal, 1984),

even for short delays (Schaal & Branch, 1988). It is possible that when the order was stated to participants, this served as a signal of when the HP item would be delivered, and this type of signal was absent in the varied sequence condition.

More research is needed to understand the conditions under which the preference for fixed or varied sequence of reinforcers exists. Future research should examine preference for a fixed sequence under conditions in which the delay to HP items, as well as amount of each reinforcer delivered is made similar in both conditions. In addition, future research should also evaluate if a preference for a fixed order of reinforcers exists when the order is signaled or unsignaled.

## Study 3: Choice versus No Choice of Reinforcers

Study 3 evaluated preference for choice of reinforcers. This study expands on previous research by evaluating the preference of choice relative to previously identified preferred conditions of either a varied or fixed sequence of high quality reinforcer delivery. Six of the seven participants continued to Study 3. One participant, Jane, was removed from the study following her leaving the school.

### Exposure Sessions

In the choice and no-choice conditions, task completion was reinforced with one of the three highly preferred reinforcers on an FR-1 schedule. In both conditions, there was an array of 21 reinforcers present in front of the child. The array had seven items for each of the three types of reinforcers and matched the quantity of each reinforcer that could be delivered in the choice and no-choice condition. In the choice condition, the participant had the opportunity to choose an item from the array. In the no-choice condition, completing the task accurately met the criteria for reinforcement and either the first, second, or third ranked item on the paired-item

preference analysis was delivered by the experimenter. Whether these items were delivered in a fixed or varied sequence in the no-choice condition was based on participant's preference from Study 2 (See Table 5 for specific comparisons and preferences for each participant). In the control condition, completing the task did not result in the presentation of a reinforcer. Prior to the start of each session, the condition was explained to the participant (i.e. "When this picture is on the table, and you answer correctly, you can choose either a fruit snack, M&M, or Starburst," if the child previously preferred the fixed sequence, the no-choice condition was described as "when this picture is on the table, and you answer correctly, I will give you a candy, it will always be in the order of fruit snack, M&M, then Starburst," and for participants who preferred the varied sequence, the no-choice condition was described as "when this picture is on the table, and you answer correctly, I will give you a candy, but you won't know which one it will be in advance").

The reinforcer delivery in the no-choice condition was not yoked to previous choice conditions. This allowed the preference of the choice condition to be compared to the condition for which the participant previously demonstrated a preference. Including conditions that were previously determined to be preferred in subsequent studies was part of the assessment model aimed at communicating the most preferred reinforcement contingency for each child.

**Preference Evaluation**

Wingdings symbols, which were correlated with the choice condition, no-choice condition, and extinction condition during the exposure sessions, were placed on the table. Preference was assessed in a concurrent-chains arrangement as described previously.

**Results and Discussion**

The choice and no-choice conditions resulted in similar rates of academic responses for

three participants, with both reinforcement conditions yielding higher rates relative to extinction conditions in the exposure sessions (see left column of Figure 3). Jenny averaged 2.6 academic responses per min in both the choice and no-choice conditions. Tara averaged 5.4 academic responses per min in the choice condition and 5.0 academic responses per min in the no-choice condition. Mary averaged 7.6 academic responses per min in the choice condition and 8.1 academic responses per min in the no-choice condition.

The no-choice condition resulted in slightly higher rates of responding for two participants in the exposure sessions (see left column of Figure 3). Alice had an average rate of 8.6 academic responses in the no-choice condition relative to an average rate of 4.6 academic responses in the choice condition, but this difference was unreliable. Zack averaged 7.1 academic responses per min in the no-choice condition and 4.0 academic responses per minute in the choice condition; but this difference was also reliable. By contrast, Jesse had slightly higher rates of responding in the choice condition with an average rate of 5.6 academic responses relative to an average rate of 4.0 academic responses in the no-choice condition. All rates were higher in the reinforcement than extinction conditions for these participants.

Five of six participants showed a preference for the condition in which choice was available; Zack showed a preference for the extinction condition (see right column of Figure 3). Of the participants who showed a preference for the choice condition, four participants (Jesse, Jenny, Alice, and Tara) exclusively chose the choice condition. Differences in response rates during the exposure sessions were uncorrelated with preferences (Figure 4).

Previous research has demonstrated that children prefer the opportunity to choose reinforcers (Fisher et al., 1997; Thompson et al., 1998; Tiger et al., 2006; Schmidt et al., 2007). This study extended this research by demonstrating that participants preferred the opportunity to

choose reinforcers, even when a previously preferred reinforcement condition was available (i.e., varied or fixed sequence). Almost all participants preferred the choice of reinforcer condition relative to the previously preferred varied or fixed sequence condition. These results suggest that the choice of reinforcers may be more influential than other parameters of reinforcement in these conditions. These results are generally consistent with those of Tiger et al. and Thompson et al. who demonstrated that choice of reinforcers affected allocation of responses more than rate of reinforcement.

As in Study 2, some participants in the choice conditions were able to access high-preference items more quickly in the choice than in the no-choice conditions; this difference may have driven preference towards the choice option. In other words, the probabilistic delays to the most highly preferred items in the no-choice conditions may have driven preference towards the choice conditions in which the most highly preferred items could be accessed without delays. This, however, seems unlikely because the majority of participants had the fixed sequence of reinforcer as the no-choice condition in which there was no delay to the HP item (Table 3). In other words, the probability of receiving the HP item on the first response was 1.0 for almost all participants in the no-choice condition. In the choice condition, most participants had a probability of receiving the HP item on the first response as a 0.3. In other words, there was an overall greater delay to the HP item in the choice condition, compared to the no-choice condition. Given that most children preferred the choice condition, it appears that delay reduction to the HP stimuli was not responsible for children's preferences.

Some differences were obtained with respect to the amount of each reinforcer delivered across conditions in Study 3. There were some differences in the amount of the different reinforcers delivered in choice relative to the no-choice condition (Table 4). For example, Jesse

and Jenny both experienced more HP items in the choice condition relative to the no-choice condition. Zack chose the item ranked third 50% of the time in the choice condition, suggesting there may have been a change in preference from the time of the item-based preference analysis to the parameter preference analysis. These differences in the amount of different types of reinforcers may have been a factor in the choice condition being more preferred.

Zack was the only participant to prefer extinction to either choice or no-choice conditions. It is important to note that Zack preferred the reinforcement to extinction conditions in his pretest and previous comparisons, so this preference towards extinction may not have been influenced by the choice/no-choice conditions. These results could suggest satiation with the stickers he was receiving, and/or a preference for a break from academic demands. As described in Study 1 with Lisa's selections of extinction, Zack may have preferred the extinction condition based on the removal of the reinforcers (acting as a potential removal of the discriminative stimuli to work), or self-imposed rules that coloring was appropriate in extinction conditions while work should be completed in reinforcement conditions. Breaks following work may serve as a reinforcer and be more preferred than positive reinforcement as demonstrated in Kodak, Lerman, Volkert, and Trosclair (2007) who had participants demonstrate a preference for a break compared to less preferred edible items. Future research should evaluate the conditions under which positive and negative reinforcement could be used in concert to maintain accurate and independent academic responding.

Study 3 was the final evaluation in the assessment of preferences for these parameters of reinforcement and compared choice to previously preferred sequences of reinforcer delivery, for participants who preferred varied reinforcer delivery to begin with. Each participant's preference for reinforcement parameters is shown in Table 5, with the specific comparisons across all three

studies. This sequence of preference assessments was used to inform caregivers on how to arrange reinforcement delivery on an individualized basis.

## General Discussion

Participants demonstrated a preference for a particular reinforcement parameter in 20 out of 23 applications, despite academic responding being similar across reinforcement parameters for 20 out of 23 applications. These outcomes suggest that, although they are sometimes correlated (Hanley, 2010), reinforcement effects and preference appear to be independent measures of the value of reinforcement parameters in particular and behavior change programs in general. A practical implication is that preference for reinforcement parameters should be evaluated in addition to their efficacy especially when both conditions act as reinforcing conditions.

Each parameter of reinforcement was briefly evaluated in a single-operant arrangement, partly to assess the reinforcement effects of that condition on academic responding. The top panel of Figure 4 shows the mean rates of responding for all participants across each reinforcement condition. The mean and variance across reinforcement conditions were relatively similar, suggesting that these factors may be relatively weak compared to other parameters of reinforcement like immediacy or quality, both of which were maximized across all reinforcement conditions in this study. Although there may have been various delays to the HP item, reinforcers were always delivered immediately following a response, and all reinforcers were of high quality as demonstrated by item-based preference analyses.

It is equally plausible that the analytic context we adopted that relied on maintenance responses was insensitive to meaningful differences that may be imposed by the manipulated reinforcement variables. It is important to note that reinforcers were assessed on an FR 1

schedule because this is a common schedule of reinforcement in teaching contexts, and we wanted to maximize experience with each reinforcement condition in the exposure sessions. There are many changes to consider to this preparation to better understand if there are meaningful differences in the efficacy of these parameters. For example, other schedules of reinforcement, including variable interval schedules, may be more sensitive measures than ratio schedules of reinforcement. In addition to measuring response rates, other measures should be evaluated to understand the effects of these parameters including resistance to extinction (see Milo, Mace, & Nevin, 2010 as an example in which varied reinforcers were shown to be more resistant to extinction compared to constant reinforcer delivery).

Responding was assessed in short sessions with an academic task, but it is unclear how responding and preference for these parameters of reinforcement may change as tasks are more difficult, or if the work periods were extended. Jesse, Jenny, and Alex were exposed to changing academic tasks as the studies progressed, which may closer approximate how a typical classroom curriculum would progress; however, all tasks were previously learned. Most of the research in parameters of reinforcement evaluated the effects of these manipulations on maintenance tasks. Although these maintenance tasks are a good starting point for research, most reinforcement procedures are used for the development and maintenance of new skills (DeLeon, Bullock, & Catania, 2013). Future evaluations should include more difficult tasks, or acquisition tasks, to determine if the general preferences observed hold up under these conditions. This research extension is important because these arrangements closer approximate the conditions in which reinforcers are used in educational settings.

Despite the lack of reliable differences in response rates of reinforcement parameters, participants exhibited a clear preference for one reinforcer parameter relative to another in all but

three applications (Figure 4). Our results demonstrated that most children preferred varied reinforcer delivery, compared to a single highly preferred reinforcer. In the evaluation of reinforcer delivery order, a majority of children preferred the fixed sequence of reinforcer delivery compared to a varied sequence. Most children preferred choice of reinforcers compared to a no-choice condition. Based on these results, if a behavior change agent cannot evaluate individual preferences quickly (e.g. a teacher in a large class, or in cases in which a program needs to be put in place quickly) it would be prudent to program choice of reinforcers from a varied array, as most participants preferred this arrangement.

Some children demonstrated a preference for extinction conditions, or made some selections of extinction conditions in preference evaluations. Rather than indicative of a preference for extinction per se, these patterns may reflect a preference for the escape from demands in the form of breaks from activities. Although the option to draw or not respond was available across conditions, there may have been an implied demand in the reinforcement conditions if the presence of reinforcers acted as a discriminative stimulus for work completion, or if there were self-imposed rules based on the experience in the exposure sessions. In the reinforcement conditions that were evaluated, only tangible, positive reinforcers were used. Future research should evaluate how different types of positive reinforcers (e.g., access to preferred toys or different types of attention) may interact and compete with negative reinforcement in the form of a break from academics when these parameters of reinforcement are manipulated. For example, researchers may want to evaluate choices among access to playing with a preferred toys, preferred snacks, and time with the teacher or a peer relative to a break condition.

In addition to evaluating positive and negative reinforcement, it should also be noted that

in this evaluation, it is unclear if the reinforcers in each array were complementary or substitutable. Complementary reinforcers are those that establish the value of one another, as responding for one reinforcer increases, responding for a complementary reinforcer will also increase. By contrast, substitutable reinforcers have inverse relations due to their functional similarity; as responding for one reinforcer increases, responding for a substitutable reinforcer decreases (Hursh, 1980). Future research should evaluate how these different types of reinforcers may affect a preference for varied reinforcer conditions, including sequences and choice opportunities. Having complimentary reinforcers may enhance preference for varied reinforcer conditions. By contrast, it seems likely that if reinforcers are substitutable in an array, preference for variation may not be as strong.

In the current evaluation, the parameter of reinforcement that was being investigated was isolated. As reinforcer conditions are implemented, it would be prudent to evaluate the effects of these parameters operating in concert with each other, as well as with negative reinforcement procedures. For example, choice arrays can include preferred toys, as well as a pass from having to complete work for a brief time period. Combining reinforcer parameters may lead to more robust differences in responding, as well as preferred teaching conditions compared to isolated manipulations. These types of outcomes are implied by the results of Athens and Vollmer (2010). Athens and Vollmer combined duration of reinforcement time with the enhanced quality of items and immediacy of the reinforcer delivery to achieve higher rates of a replacement behavior for problem behavior. Future research should further examine the effects of choice in combination with other parameters not previously evaluated including delay, magnitude, and whether reinforcer delivery is signaled or not.

Our analysis demonstrated that reinforcer variation, sequence, and choice are

reinforcement parameters that should be considered in their own right. Differences in preferences for these parameters did not appear to be driven by more traditional parameters. For example, delay has been shown to influence responding in previous studies, however, participants preferred conditions in which the high preference item was not always delivered first (as was the case in the varied condition, varied sequence condition, and some choice conditions; Table 3). In addition, it did not appear that the overall rate of reinforcer delivery controlled preferences (Table 4). It appears as though the parameters manipulated in this study operate independently of traditional parameters of positive reinforcement, at least under some conditions.

In addition to determining the value of reinforcer variation, sequence, and choice to young learners with and without disabilities, a secondary aim of this study was to create an assessment process that could be used to determine preference for various reinforcer delivery parameters. This process could be used in educational contexts as a way to develop highly preferred reinforcement contingencies for individual leaners. Future research should therefore be aimed at improving the efficiency and evaluating the feasibility of a similar process with teachers in classrooms.

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Table 1
*Participant Setting, Tasks, and Materials*

| Participant | Setting | Tasks | Materials |
|---|---|---|---|
| Jesse | Special education classroom | Addition worksheets increasing in complexity | Worksheets with 20 addition problems, pencils, and plain paper |
| Jenny & Alex | Special education classroom | Grammar worksheets increasing in complexity | Worksheets with 20 grammar problems, pencils, and plain paper |
| Max | Autism classroom | Writing the letter “M” | Lined paper, markers, and plain paper |
| Alice, Mary, Tara, Zack, Jane & Lisa | General education classrooom | Writing the alphabet, both upper and lower case | Lined paper, pencils, and plain paper |

Table 2
*Participant Reinforcers Across Conditions with Percentage of Approach Responses in Paired-Item Preference Analyses*

| Participant | Constant/ Varied | Fixed Sequence/ Varied Sequence | Choice/ No-Choice |
|---|---|---|---|
| Jesse | Starbursts (100)<br>Popcorn (88)<br>Fruit Snack (66) | Sour Patch Kids (88)<br>Cheetos(88)<br>Starbursts (77) | Fruit Snack(88)<br>Star Bursts (88)<br>M&Ms (77) |
| Jenny | Starbursts (77)<br>M&M's (77)<br>Fruit Snacks (66) | Starbursts (88)<br>Skittle (66)<br>Fruit Snacks (66) | Fruit Snacks (88)<br>Popcorn (66)<br>Chips (66) |
| Alex | Starbursts (77)<br>Sour Patch Kids (66)<br>Skittles (66) | -- | -- |
| Max | Skittle (100)<br>M&M's (88)<br>Reeses Pieces (77) | -- | -- |
| Alice | Princesses (100)<br>Dora the Explorer (88)<br>My Little Pony (77) | Princesses (77)<br>My Little Pony (66)<br>Hello Kitty (55) | Dora the Explorer (66)<br>Hello Kitty (66)<br>Animals (66) |
| Mary | My Little Pony (100)<br>Spongebob (77)<br>Dora the Explorer (55) | My Little Pony (66)<br>Princesses (66)<br>Sayings (66) | Hello Kitty (100)<br>Princesses (66)<br>Spongebob (88) |
| Tara | My Little Pony (88)<br>Spongebob (77)<br>Dora the Explorer (66) | Hello Kitty (100)<br>Spongebob (77)<br>My Little Pony (77) | Hello Kitty (88)<br>Dora the Explorer (77)<br>My Little Pony (77) |
| Zack | Ninja Turtles (88)<br>Spiderman (88)<br>Superman (66) | Ninja Turtles (88)<br>Spiderman (88)<br>Cars (66) | Iron Man (77)<br>Cars (77)<br>Spiderman (66) |
| Jane | Hello Kitty (77)<br>Princesses (77)<br>Spongebob (66) | Princesses (88)<br>My Little Pony (77)<br>Hello Kitty (66) | -- |
| Lisa | Princessses (88)<br>Hello Kitty (77)<br>My Little Pony (77) | -- | -- |

Note. Some participants received edible items as reinforcers (e.g., Skittles, M&M's, Starbursts), while others received stickers to place on construction paper (e.g., Princesses, Hello Kitty, Ninja Turtles).

Table 3
*Probability of Receiving HP Item as First Reinforcer During Exposure Sessions*

| Participant | Constant | Varied | Fixed Sequence | Varied Sequence | Choice | No-Choice |
|---|---|---|---|---|---|---|
| Jesse | 1.0 | 0.0* | 1.0* | 0.7 | 1.0* | 1.0 |
| Jenny | 1.0 | 0.0* | 1.0 | 0.0* | 0.3* | 1.0 |
| Alex | 1.0 | 0.0 | n/a | n/a | n/a | n/a |
| Max | 1.0* | 0.0 | n/a | n/a | n/a | n/a |
| Alice | 1.0 | 0.3* | 1.0 | 0.3* | 0* | 0 |
| Mary | 1.0 | 0.3* | 1.0* | 0.3 | 0.3* | 1.0 |
| Tara | 1.0 | 0.3* | 1.0* | 0.3 | 0.3* | 1.0 |
| Zack | 1.0 | 0.3* | 1.0* | 0.3 | 0.0 | 1.0 |
| Jane | 1.0 | 0.2* | 1.0* | 0.3 | n/a | n/a |
| Lisa | 1.0 | 0.2 | n/a | n/a | n/a | n/a |

*Note.* An asterisk notes a preference for a reinforcement condition. Comparisons that were not completed are noted with "n/a."

Table 4
*Percentage of Trials In Which Each Reinforcer was Delivered During Exposure Sessions*

| Participant | | Constant | Varied | Fixed Sequence | Varied Sequence | Choice | No-Choice |
|---|---|---|---|---|---|---|---|
| Jesse | | | | | | | |
| | 1 | 100 | 28* | 38* | 36 | 40* | 45 |
| | 2 | 0 | 31 | 31 | 29 | 27 | 41 |
| | 3 | 0 | 38 | 31 | 36 | 33 | 39 |
| Jenny | | | | | | | |
| | 1 | 100 | 35* | 35 | 35* | 65* | 42 |
| | 2 | 0 | 33 | 35 | 35 | 9 | 38 |
| | 3 | 0 | 32 | 30 | 30 | 26 | 30 |
| Alex | | | | | | | |
| | 1 | 100 | 35 | n/a | n/a | n/a | n/a |
| | 2 | 0 | 35 | | | | |
| | 3 | 0 | 30 | | | | |
| Max | | | | | | | |
| | 1 | 100* | 36 | n/a | n/a | n/a | n/a |
| | 2 | 0 | 31 | | | | |
| | 3 | 0 | 32 | | | | |
| Alice | | | | | | | |
| | 1 | 100 | 28* | 36 | 32* | 40* | 27 |
| | 2 | 0 | 36 | 32 | 32 | 40 | 27 |
| | 3 | 0 | 36 | 32 | 36 | 20 | 46 |
| Mary | | | | | | | |
| | 1 | 100 | 34* | 34* | 44 | 36* | 35 |
| | 2 | 0 | 39 | 33 | 30 | 30 | 35 |
| | 3 | 0 | 27 | 33 | 26 | 34 | 30 |
| Tara | | | | | | | |
| | 1 | 100 | 38* | 36* | 39 | 36* | 36 |
| | 2 | 0 | 31 | 34 | 32 | 21 | 34 |
| | 3 | 0 | 31 | 30 | 29 | 43 | 30 |
| Zack | | | | | | | |
| | 1 | 100 | 36* | 34* | 32 | 42 | 35 |
| | 2 | 0 | 31 | 33 | 29 | 8 | 35 |
| | 3 | 0 | 36 | 33 | 39 | 50 | 30 |
| Jane | | | | | | | |
| | 1 | 100 | 43* | 36* | 36 | n/a | n/a |
| | 2 | 0 | 22 | 34 | 34 | | |
| | 3 | 0 | 33 | 30 | 30 | | |
| Lisa | | | | | | | |
| | 1 | 100 | 35 | n/a | n/a | n/a | n/a |
| | 2 | 0 | 32 | | | | |
| | 3 | 0 | 33 | | | | |

*Note.* An asterisk notes a preference for a reinforcement condition. Comparisons that were not completed are noted with "n/a."

Table 5
*Participant Conditions and Preferences Across Studies*

| Participant | Study 1 | Study 2 | Study 3 |
|---|---|---|---|
| Jesse | Constant/ Varied* | Varied Sequence/ Fixed Sequence* | Fixed Sequence/ Choice* |
| Jenny | Constant/ Varied* | Varied Sequence*/ Fixed Sequence | Varied Sequence/ Choice* |
| Alex | Constant/ Varied (n/a) | -- | -- |
| Max | Constant*/ Varied | -- | -- |
| Alice | Constant/ Varied* | Varied Sequence*/ Fixed Sequence | Varied Sequence/ Choice* |
| Mary | Constant/ Varied* | Varied Sequence/ Fixed Sequence* | Fixed Sequence/ Choice* |
| Tara | Constant/ Varied* | Varied Sequence/ Fixed Sequence* | Fixed Sequence/ Choice* |
| Zack | Constant/ Varied* | Varied Sequence/ Fixed Sequence* | Fixed Sequence/ Choice (n/a) |
| Jane | Constant/ Varied* | Varied Sequence/ Fixed Sequence* | -- |
| Lisa | Constant/ Varied (n/a) | -- | -- |

*Note.* An asterisk notes a preference for a reinforcement condition. Preference evaluations that were not completed are noted with "--." Comparisons where there was no preference for a reinforcement condition (i.e. a preference for extinction, or selections between two conditions) are noted with "n/a".

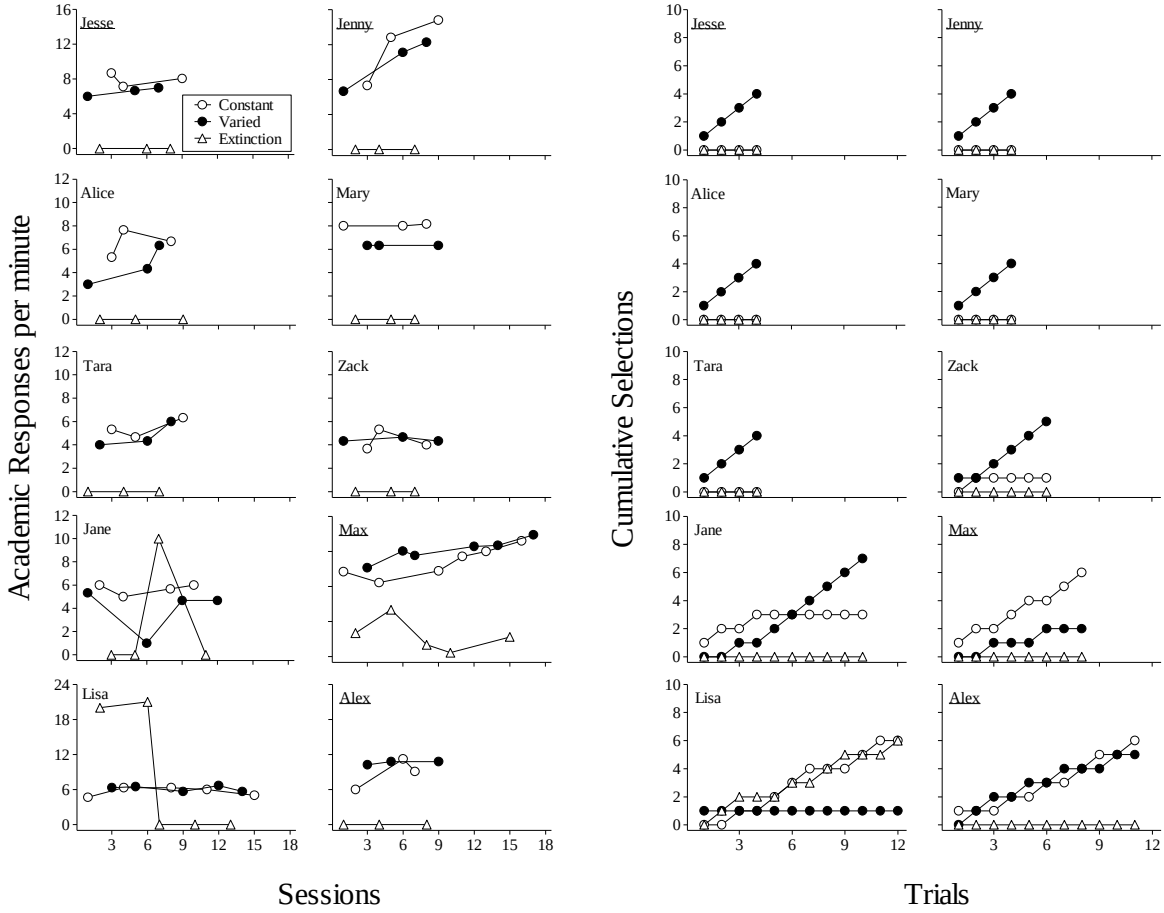


*Figure 1.* Data for Study 1 evaluating preference for constant and varied reinforcers, as well as extinction conditions including exposure sessions (left) and preference evaluations (right) Students whose names are underlined were enrolled in special education classrooms.

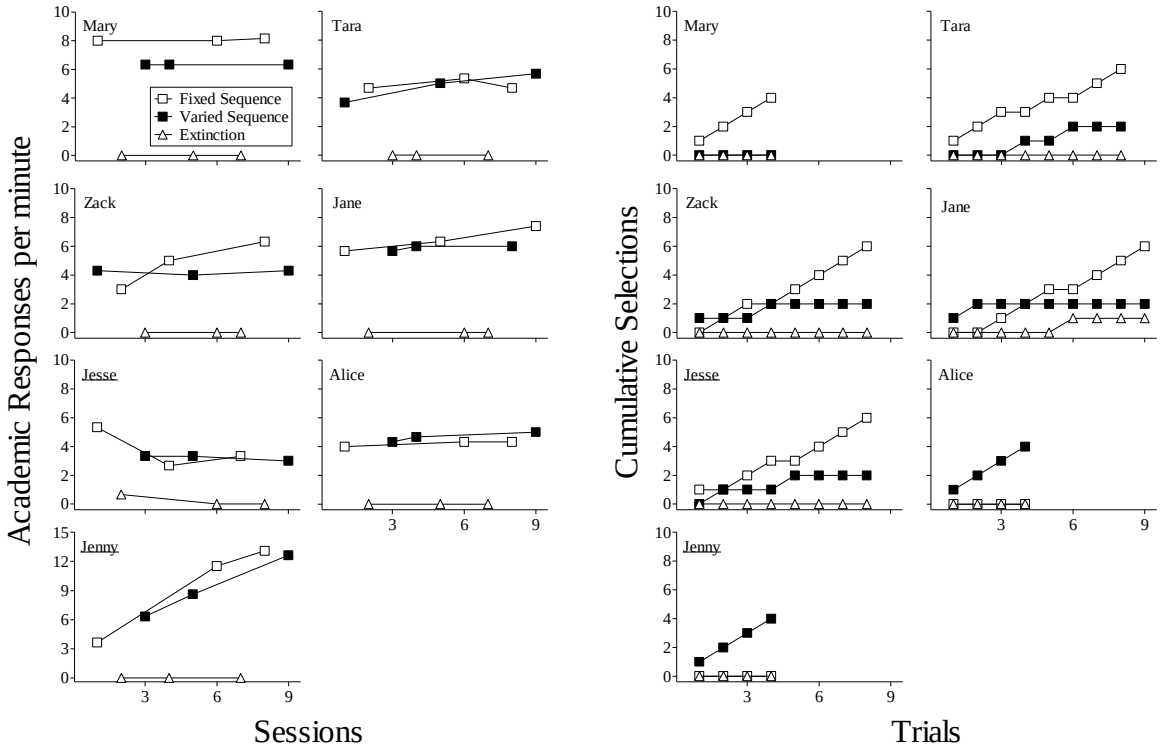


*Figure 2.* Data from Study 2 comparing the relative preference for fixed sequence, varied sequence, and extinction. Exposure sessions are on the left, and preference evaluations are on the right. Students whose names are underlined were enrolled in special education classrooms.

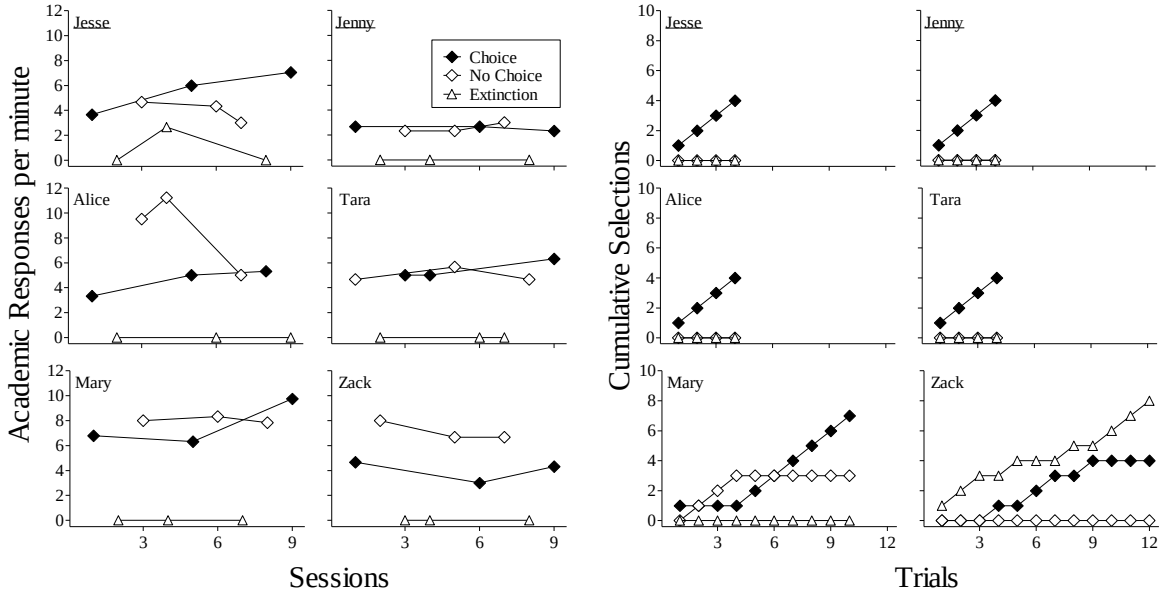


*Figure 3.* Data from Study 3 evaluating the relative preference for choice, no- choice, and extinction conditions. Exposure sessions are on the left, and preference evaluations are on the right. Students whose names are underlined were enrolled in special education classrooms.

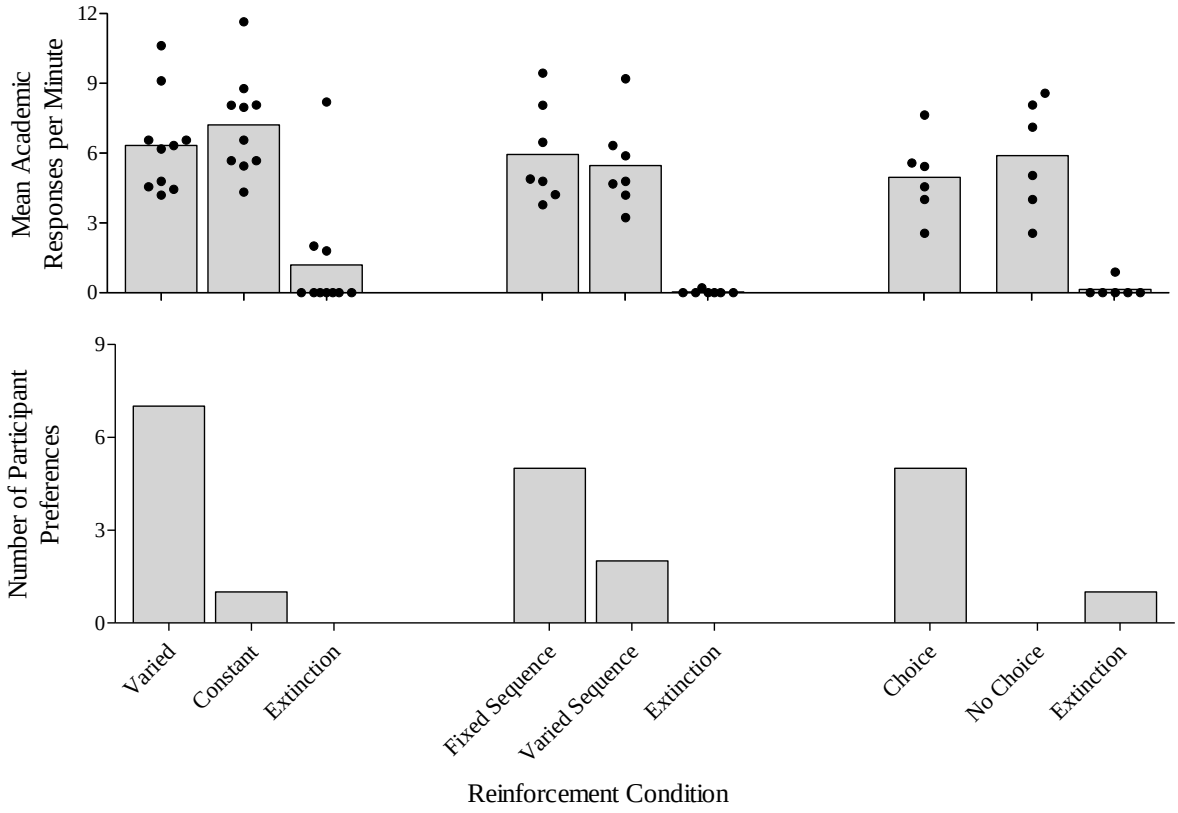


*Figure 4.* Aggregate data for average rate of responding across reinforcement conditions. Bars represent the average for all participants and black circles represent individual participant's average rate of responding for all exposure sessions. The bottom panel shows the number of participants who demonstrated a preference for each reinforcement condition.