EVALUATING THE EFFECTS OF REINFORCER CHOICE AND REINFORCER VARIATION ON RESPONSE RATES OF CHILDREN WITH AUTISM

by

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Evaluating the Effects of Reinforcer Choice and Reinforcer Variation on the Response Rates of Children with Autism

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Motivating individuals with autism can be challenging for clinicians and educators seeking to increase skills or decrease problem behaviors. Even when highly preferred reinforcers have been identified, they tend to lose their effectiveness over time. Over the years, several strategies have been developed to maintain the effectiveness of reinforcers. Reinforcer variation has been demonstrated to attenuate decreases in responding associated with repeated exposure to a single reinforcer. Another strategy that has been used to help maintain responding is allowing an individual a choice among reinforcers. Several researchers have suggested that providing choice among several reinforcers may produce the same effects on responding as reinforcer variation. Although these two procedures have been shown to maintain motivation in individuals with autism, they have not been systematically compared and evaluated against each other. In this study, we evaluated the effects of reinforcer variation as compared to reinforcer choice.
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CONTENTS

ABSTRACT ......................................................................................................................... iii

AKNOWLEDGMENTS .............................................................................................. iv

LIST OF TABLES ......................................................................................................... vii

LIST OF FIGURES .......................................................................................................... viii

CHAPTER

I. INTRODUCTION ....................................................................................................... 1

Identifying Effective Reinforcers ................................................................................. 2
Changes in Reinforcer Effectiveness ........................................................................... 5
Methods to Maintain Reinforcer Effectiveness ......................................................... 7
Purpose ........................................................................................................................... 22

II. METHODS .................................................................................................................. 24

Participants, Setting and Materials ............................................................................. 24
Response Measurement and Interobserver Agreement ................................................. 25
Preference Assessments .............................................................................................. 26
Treatment Integrity ...................................................................................................... 27
Preexperimental Procedures ......................................................................................... 28
Research Design ........................................................................................................... 29
Experimental Procedures ........................................................................................... 29

III. RESULTS .................................................................................................................. 35

IV. DISCUSSION ............................................................................................................. 43

Limitations ...................................................................................................................... 44
Implications and Conclusions ...................................................................................... 47

REFERENCES .............................................................................................................. 50

APPENDICES ............................................................................................................... 58

Appendix A: 16-Item Paired-Stimulus Preference Assessment Data Sheet ............ 59
Appendix B: 8-Item Paired-Stimulus Preference Assessment Data Sheet ............... 61
<table>
<thead>
<tr>
<th>Appendix</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Sample Varied Reinforcer Data Sheet</td>
<td>63</td>
</tr>
<tr>
<td>D</td>
<td>Letter of Information</td>
<td>66</td>
</tr>
<tr>
<td></td>
<td>CURRICULUM VITAE</td>
<td>69</td>
</tr>
<tr>
<td>Table</td>
<td>Page</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Tentative List of the Empirical Characteristics of Habituation</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>Order of Conditions for Each Participant</td>
<td>30</td>
</tr>
<tr>
<td>Figure</td>
<td>Description</td>
<td>Page</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>1</td>
<td>Results of the 16-item paired-stimulus preference assessment for edibles and</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>the 8-item paired-stimulus preference assessment for leisure items for each participant</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Rates of responding during baseline, single, varied and choice conditions for each participant</td>
<td>39</td>
</tr>
<tr>
<td>3</td>
<td>Responses per minute during the concurrent operant condition for Arlo and Elliott</td>
<td>41</td>
</tr>
</tbody>
</table>
Autism is a developmental disability characterized by deficits in both social functioning as well as communication. Additionally, individuals with autism often engage in repetitive or stereotyped behaviors that can interfere with normal functioning (American Psychiatric Association, 2000). Intensive behavior analytic interventions have been demonstrated to be highly effective at facilitating significant improvements in behaviors associated with all three primary characteristics of autism (Howard, Sparkman, Cohen, Green, & Stanislaw, 2005; Sallows & Graupner, 2005). For example, Howard et al. (2005) compared an intensive, behavior analytic treatment approach to both an intensive “eclectic” treatment approach and a non-intensive, traditional early intervention approach. After approximately 14 months, children in the intensive behavior analytic treatment group demonstrated higher mean scores in all assessed skill domains such as communication, self-help and social skills. Because reinforcement is a central mechanism to behavior change in these interventions, it is important to utilize reinforcers that effect the most change in behavior (Amari, Grace, & Fisher, 1995). However, reinforcers that maintain behavior in typically developing individuals, or are chosen based on caregiver report, often fail to motivate individuals with developmental disabilities (Fisher et al., 1992).

This characteristic lack of “natural” motivation can pose problems for clinicians and educators during the development and implementation of behavioral interventions. For instance, individuals with autism may not find social interactions or other naturally
occurring consequences for behavior reinforcing. As an example, a caregiver may greet their child when they arrive home from work. For typically developing children, an appropriate response might be to return the greeting and subsequently receive a hug from the caregiver as a reinforcer. For some individuals with autism, however, the naturally occurring reinforcers (e.g., hugs) associated with greetings may not be as successful at maintaining this behavior and effective reinforcers may be difficult to identify (Green et al., 1988). As a result, researchers have developed and demonstrated the importance of using systematic methods to identify effective reinforcers, called stimulus preference assessments.

Identifying Effective Reinforcers

Preference assessments are a primary tool by which educators, clinicians and researchers can address motivational deficits in individuals with a limited or idiosyncratic range of reinforcers. Over the past 20 years, a variety of preference assessment methods have been developed by researchers to systematically identify stimuli that may function as reinforcers. Formats include single item presentations (Pace, Ivancic, Edwards, Iwata, & Page, 1985), stimuli presented in pairs (Fisher et al., 1992) and those presented in multiple stimulus arrays (DeLeon & Iwata, 1996). In a single item preference assessment, items are presented one at a time to an individual. Those items that the individual approaches more often are considered more likely to function as reinforcers than items never approached or approached less frequently. A paired-stimulus preference assessment consists of evaluating a group of stimuli in pairs. Each item is paired once with every other item. Two items per trial are presented to an individual with an
instruction such as “pick one”. Based on an individual’s selections, patterns or hierarchies are revealed that indicate which items are most likely to function as reinforcers for an individual. In a multiple stimulus without replacement preference assessment, a variety of items (e.g., 5-10) are presented to an individual at the same time. The individual is instructed to pick one out of the array. Subsequent trials present the remaining items in the group until all items have been selected or until the individual stops making selections. Similar to the paired-choice preference assessment, a hierarchy is obtained and indicates which stimuli are most likely to function as reinforcers. In clinical or educational settings, these stimuli are then incorporated into instructional interventions or behavior reduction programs as reinforcers for desired behavior. However, it is important to emphasize that preference assessments only identify preferred items and do not always indicate which items will actually function as reinforcers and maintain responding (Roscoe, Iwata, & Kahng, 1999). For example, Paclawskyj and Vollmer (1995) found that some items identified as preferred in the single stimulus preference assessment did not function as reinforcers during subsequent reinforcer assessments. That is to say, the single stimulus preference assessment identified false positive reinforcers.

When conducting research, it is necessary to demonstrate that preferred stimuli will indeed act as reinforcers for responding. During these empirical demonstrations of reinforcer effectiveness, called reinforcer assessments, items previously identified as preferred are provided contingent on responding. Those stimuli associated with the most responding are considered the most effective reinforcers and are subsequently used in treatment packages.
Reinforcer assessments can be conducted using a single or concurrent operant arrangement (Fisher et al., 1997; Roscoe, et al., 1999). In a single operant format, a single response option is available and responses are reinforced with one type of reinforcer. This format assesses *absolute* rates of responding in isolation of other reinforcers and demonstrates how effective a particular reinforcer is when no other reinforcers are available. In contrast, a concurrent operant format assesses responding on two or more concurrently available response options, each associated with a different reinforcer. A concurrent operant format assesses *relative* rates of responding or, in other words, an individual’s preference for one reinforcer over others. The decision to use a single versus concurrent operant reinforcer assessment is dependent on the goals of treatment. If it is important to identify which of several potential reinforcers is the most effective, a concurrent operant format may be warranted including evaluations under different schedules of reinforcement (e.g., ratio vs. interval; Fisher & Mazur, 1997). If it is important to identify whether any preferred stimulus will function as a reinforcer, a single operant format is most ideal. In many cases, reinforcers are evaluated under both single and concurrent operant arrangements (Shahan, Bickel, Madden & Badger, 1999).

Nevertheless, even high quality reinforcers identified using systematic preference assessments can lose their effectiveness over time (Egel, 1980, 1981). This loss of reinforcer effectiveness can be difficult to address when working with individuals with an extremely limited number of available reinforcers. Thus, it seems important to evaluate and compare the effects of different procedures aimed at maintaining reinforcer value on responding.
Changes in Reinforcer Effectiveness

Even when using empirically-determined, highly preferred reinforcers, a number of factors can affect responding during interventions. One factor that comes into play is repeated exposure to the same reinforcer. Reinforcers have been shown to lose their effectiveness to maintain responding over time (Egel, 1980, 1981). This can be especially problematic for clinicians and educators that rely on reinforcers to effect positive change in their clients and students. When working with individuals with a limited number of identified reinforcers, a loss of reinforcer effectiveness can be particularly challenging because if these reinforcers lose their potency, appropriate responding will also likely decrease.

A decrease in reinforcer effectiveness can be conceptualized as a change in motivating operations such that repeated exposure to the same reinforcer decreases an individual’s motivation to respond for that item. Many researchers attribute decreases in reinforcer effectiveness to satiation (Egel, 1980, 1981; Vollmer & Iwata, 1991). Behavior analysts typically define satiation as a decrease in operant responding presumed to be caused by repeated contact with a reinforcer (Cooper, Heron, & Heward, 2007, p. 39). Despite the term’s use within the behavior analytic community, there is little empirical evidence to support satiation as an explanation for decreases in operant responding (Murphy, McSweeney, Smith, & McComas, 2003). More specifically, satiation is only a label of behavior rather than an explanation of behavior. Originally borrowed from the field of ingestive research, the term satiation was modified by behavior analysts in the absence of an experimental analysis (McSweeney, 2004).
Without an experimental analysis of satiation, researchers are left with little information about underlying mechanisms behind changes in reinforcer effectiveness or guidance as to how to increase (or decrease) reinforcer effectiveness. Additionally, the characteristics of behavior undergoing satiation (as traditionally defined; e.g., stomach distension, increases in blood sugar levels) differ across stimuli such as food and water and have not been identified for noningestive stimuli (e.g., attention, toys) often used by applied behavior analysts (Murphy et al., 2003).

An alternative characterization suggests that reinforcers lose their effectiveness due to habituation. Habituation is defined as a decrease in responsiveness (e.g., operant responding) to a repeatedly presented stimulus (e.g., reinforcer). Although the general definitions of satiation and habituation share similarities, the habituation account is supported by an empirical research base. Table 1 depicts a tentative list of 14 characteristics associated with habituation (McSweeney & Murphy, 2000). Behavior undergoing habituation has been shown to demonstrate at least some of these characteristics. For example, Characteristic 3 (variety effect) states that habituation occurs more slowly to stimuli (e.g., reinforcers) that are presented in a variable rather than fixed manner. This characteristic accounts for both the type of reinforcer presented (variation among multiple reinforcers) as well as the schedule of reinforcer delivery (variable schedules maintain behavior better than fixed schedules). Both basic animal and human research has demonstrated that presenting varied reinforcers can often result in subjects responding at faster rates (Melville et al., 1997; Egel, 1980, 1981). From a satiation perspective, this does not make intuitive sense because, for example, in the case of food, subjects often consumed more reinforcers and thus more calories than in single
item sessions. If satiation is the primary reason for decreases in responding, consuming more reinforcers should result in more rapid decreases in responding.

Although it is not the purpose of this discussion to determine whether decreases in operant responding are due to satiation or habituation, the habituation account has empirically tested characteristics that could provide researchers with a basis for more comprehensive analyses of changes in reinforcer effectiveness. For a more in-depth discussion of the satiation-habituation characterizations of behavior see McSweeney and Murphy (2000) and Murphy et al. (2003).

Methods to Maintain Reinforcer Effectiveness

Reinforcer Variation

As mentioned in the preceding paragraphs, one strategy to address decreases in reinforcer effectiveness is to vary reinforcers, rather than presenting the same reinforcer repeatedly. In general, reinforcer variation consists of someone other than the consumer selecting from an array of different reinforcers at each scheduled delivery. This method contrasts with delivering a single constant reinforcer for each reinforced response. Reinforcer variation is a valuable procedure by which to increase and/or maintain the effectiveness of reinforcers (Egel, 1980, 1981; Facon & Darge, 1996; Najdowski, Wallace, Penrod, & Cleveland, 2005)

Several studies have evaluated the effects of reinforcer variation on responding in individuals with disabilities. Egel (1980) for example, compared the effects of three single edible reinforcers (constant) to the effects of those same three edibles when presented randomly (varied) on bar pressing in children with autism. During the constant
Table 1

Tentative List of the Empirical Characteristics of Habituation (from McSweeney & Murphy, 2000)

1. Spontaneous recovery: Responsiveness to a habituated stimulus recovers when that stimulus is not presented for a time.
2. Stimulus specificity (Swithers & Hall, 1994; Whitlow, 1975): Habituation is disrupted by changes in the presented stimulus.
3. Variety effects (Broster & Rankin, 1994): Perhaps because of stimulus specificity, habituation occurs more slowly to stimuli that are presented in a variable, rather than fixed manner (e.g., after variable, rather than fixed interstimulus intervals).
4. Dishabituation: Presenting a strong, different or extra stimulus restores responsiveness to a habituation stimulus. Although dishabituation is listed here as a characteristic of habituation, researchers disagree about whether the return of responsiveness occurs because habituation decreases (Marcus, Nolen, Rankin, & Carew, 1988) or because sensitization is added (Groves & Thompson, 1970; see the discussion of sensitization below).
5. Dishabituation habituates: Repeated presentation of dishabituators reduces their ability to restore habituation responding.
6. Stimulus rate: Faster rates of stimulus presentation yield faster and more pronounced habituation than slower rates.
7. Stimulus rate and recovery: Spontaneous recovery may be faster after faster than after slower rates of stimulus presentation (Staddon & Higga, 1996).
8. Stimulus exposure: Responsiveness to a repeatedly presented stimulus decreases with increases in stimulus exposure.
9. Long-term habituation (Wagner, 1976). Spontaneous recovery may be incomplete. Some habituation is learned and persists over time.
10. Repeated habituations: Perhaps because of long-term habituation, habituation may become more rapid with repeated habituation followed by spontaneous recovery.
11. Stimulus intensity: Habituation is sometimes, but not always (Groves & Thompson, 1970), faster and more pronounced for less intense than for more intense stimuli.
12. Generality (Thorpe, 1966): Habituation occurs for most if not all, species of animals. It also occurs for most stimuli, including those that have no ingestive consequences (e.g., lights, noises). The exact rate of habituation differs depending on the species, the stimulus, the response used as a measure, and the individual subject (Hinde, 1970).

Habituation is often accompanied by “sensitization” (Groves & Thompson, 1970). Therefore, if habituation occurs, the following phenomena might also be observed:

13. Sensitization by early-stimulus presentations (Groves & Thompson, 1970): An increase (sensitization), rather than a decrease (habituation), in responsiveness may occur to a repeatedly presented stimulus during its first few presentations.
14. Sensitization by stimuli from another modality (Swithers & Hall, 1994): An increase in responsiveness to a stimulus may be produced by the introduction of a stimulus from another modality (e.g., a light or noise). Both sensitization and dishabituation (Characteristic 4) may involve the introduction of a stimulus from another modality. Results are conventionally described as dishabituation if the stimulus restores responsiveness to an already habituated stimulus and as sensitization if the stimulus from another modality increases responding before substantial habituation occurs to the other stimulus (Marcus et al., 1988).
reinforcer condition, a single identical reinforcer was delivered on a fixed ratio (FR) 1 schedule of reinforcement throughout a session. The varied reinforcer condition consisted of delivering all three reinforcers in a random order with no single reinforcer delivered more than four times in a row on an FR 1 schedule of reinforcement. Based on the cumulative number of responses for each of the 10 participants, the highest number of responses occurred during the varied condition. Rates of bar pressing were also higher in the varied reinforcer condition as compared to the constant reinforcer condition. An additional finding was that for eight participants, the satiation criteria (three responses or less in a three consecutive minute period) were never met during the varied condition whereas all 10 participants met the satiation criteria during the constant reinforcer condition.

In a follow-up study, Egel (1981) compared the effects of constant versus varied reinforcers on academic responding in three children with autism. Data were collected on the percentage of correct responses for discrete trial tasks (e.g., pointing to an object when the instructor said its name) as well as the percentage of time each participant was considered on-task. Similar to the results of the initial study, all three participants demonstrated decreasing levels of responding during the constant reinforcer condition and consistently met the satiation criterion of a failure to respond for three consecutive trials. During the varied reinforcer condition, participants engaged in higher percentages of correct responding and on task behavior and never met the satiation criterion. The opposing trends in responding between the constant and varied reinforcer conditions appeared to be a function of the participants’ motivation. That is, varying reinforcers increased participant motivation to respond.
Reinforcer variation has also been evaluated with additional types of reinforcers such as leisure items (Facon & Darge, 1996), and other sensory stimuli (Rincover & Newsom, 1985; Rincover, Newsom, Lovaas, & Koegel, 1966;). Facon and Darge (1996), for example, evaluated the effects of toy variation on the switch pressing of children with disabilities. The results of the study indicated that variation of toys could prevent or postpone decreases in responding associated with repeated exposure to a single toy. In a study that evaluated food and sensory stimuli, Rincover and Newsom (1985) found that response rates of participants were at least slightly higher when multiple sensory and multiple food reinforcers were used (i.e., varied) versus single sensory or single food items alone with the most significant differences in responding occurring between multiple sensory and single sensory evaluations.

Other aspects of reinforcer variation have been examined within the literature. Bowman, Piazza, Fisher, Hagopian, and Kogan (1997) assessed the preference of children for receiving slightly lower quality varied reinforcers versus a constant high quality reinforcer for responding. Despite differences in the hierarchical preference ranks between the reinforcers in the varied condition and the single constant condition, four out of seven participants demonstrated a preference for the varied reinforcers in a concurrent operant arrangement. An additional participant was reported to have allocated responding equally between both alternatives thus resulting in what the authors referred to as a form of participant imposed reinforcer variation. The authors concluded that for some individuals, reinforcer variation might compete effectively with a single, more highly preferred reinforcer and that some individuals may prefer varied reinforcers over single constant reinforcers.
Reinforcer variation has also been associated with higher percentages of correct responding during discrete trial tasks and increases in on-task behavior (Egel, 1981; Najdowski et al., 2005). Thus, in addition to preventing decrements in free-operant responding associated with the delivery of a single constant reinforcer, reinforcer variation may positively affect additional measures of behavior such as response accuracy and on-task behavior. For example, Najdowski et al. (2005) found that variation among low preference reinforcers was just as effective as a single constant high preference reinforcer in acquiring and maintaining levels of correct responding during discrete trial tasks. Participants also engaged in similar levels of on-task behavior regardless of the condition in effect.

Another important factor related to reinforcer effectiveness is response persistence or resistance to change. In a recent study, Milo, Mace, and Nevin (2010) evaluated preference and response persistence for varied versus constant reinforcers in four boys with autism. After conducting a 10-item MSWO preference assessment for food (DeLeon & Iwata, 1996) the top three items were subsequently presented as reinforcers in several conditions. In the first condition, an FR 1 FR 1 concurrent operant format was used to assess preference for the three single, constant reinforcers as compared to those same three items when presented in a varied format. Three sessions were conducted that assessed participant preference for varied reinforcers versus each of the single constant reinforcers. Overall, response rates were higher for varied reinforcers indicating that all four participants preferred varied reinforcers to single constant reinforcers. Using a multiple FR 10 FR 10 schedule, a second condition evaluated response rates for the three single constant versus varied reinforcers. During this
condition, the single constant reinforcer component was alternated every two minutes with the varied reinforcer component. Results demonstrated that all four participants exhibited on average, higher response rates during the varied reinforcer component. A final test condition was designed to assess resistance to change (response persistence) when participants were exposed to a preferred video during the multiple FR 10 FR10 component. Results from these test conditions suggest that participant responding for varied reinforcers was more resistant to distraction than responding for single constant reinforcers.

Although most studies evaluating varied reinforcers demonstrated positive effects on responding, some investigations have found that varied reinforcers were not more effective at maintaining responding. Koehler, Iwata, Roscoe, Rolider, and O’Steen (2005) for example, found that variation of nonpreferred stimuli (items not approached during a single stimulus preference assessment) did not enhance responding above single constant baseline rates for those items. One potential explanation for these results is the level or hierarchy of preference for assessed items. In the case of nonpreferred items, there is likely to be little to no difference between responding in constant and varied conditions simply because nonpreferred items do not support any responding (floor effects). However, differences in responding between constant and varied conditions may also be minimized or overshadowed when high preference items are assessed (Bowman et al., 1997). Essentially, differences in response rates between constant and varied reinforcers are not detected, possibly because high preference items are more influential than any effects of varied reinforcers on response rates (ceiling effects). Although other factors such as the schedule of reinforcement or response effort can also
affect outcomes, level of preference may play an important role in whether researchers can detect differences between conditions of constant and varied reinforcers.

Although not all studies demonstrated a clear effect on responding, reinforcer variation appears to be an effective method for maintaining important behaviors even when less preferred stimuli are used as reinforcers. Incorporating a variety of reinforcers into behavioral interventions is relatively simple and can attenuate decreases in responding due to a loss of reinforcer effectiveness. As a result, behavioral interventions are more likely to succeed with individuals with limited amounts of potent reinforcers.

Choice

Another method for preserving reinforcer effectiveness is to offer the individual a choice of reinforcers. Choice is generally defined as the opportunity to select from two or more alternatives (Brigham, 1979). Many situations can involve choice. Researchers have evaluated the effects of choice using a range of stimuli such as choice of reinforcers (Fisher et al., 1997), choice of preferred leisure activities (Kennedy & Haring, 1993) choice of tasks (Dyer, Dunlap, & Winterling, 1990) and choice of task sequences (Smeltzer, Graff, Ahearn, & Libby, 2009) on a variety of behaviors.

Research on reinforcer choice in particular has been a focus of several studies. Graff, Libby and Green, (1998) evaluated the effects of choice of reinforcers on free-operant response rates, levels of off-task behavior, and levels of challenging behavior in two individuals with severe disabilities using a single operant arrangement. Three conditions were evaluated via a multielement design. During the choice condition, participants were allowed to select one out of an array of three different reinforcers each time they met the reinforcement requirement. Another condition assessed the effects of
experimenter chosen reinforcers. In this condition, the experimenter placed three identical reinforcers in front of the participant from which they could choose one. The three identical reinforcers were different at each scheduled delivery such that no edible of the same type was presented more than twice in a row. A third condition allowed participants to select from an array of three identical reinforcers that remained constant throughout the session (i.e., only one type of reinforcer was presented throughout a session). Results of for both participants indicated that response rates were on average, higher in the participant selected choice condition than those observed in the experimenter selected or constant reinforcer conditions although these differences were not large. Consistent with previous research however, levels of off-task behavior and challenging behavior were significantly lower in the participant selected condition. Despite these results, several limitations prevent us from concluding that reinforcer choice produces better response rates than experimenter selected or constant reinforcer conditions. First, during the experimenter and constant reinforcer conditions, participants still had choice opportunities. Specifically, participants were allowed to choose from an array of identical items. Subsequent investigations on choice (Tiger, Hanley, & Hernandez, 2006) have demonstrated that choice itself among identical reinforcers can function as a reinforcer and that in this particular study choice was not entirely controlled for across conditions. It is possible that the minimal differences in response rates across conditions was due to choice options being available in some form across all conditions. Another potential influential factor is that while participants were reported to have varied their choices among reinforcers, this was not explicitly controlled for. That is, a participant may have selected all of the reinforcers at least once during a session but not
equally across all reinforcers. For example, it may be important to equate exposure to each reinforcer across both choice and no-choice conditions so that choice itself can be isolated more readily.

Lerman et al. (1997) conducted a study in which individuals with developmental disabilities were exposed to choice and no-choice conditions. Using a single-operant format, choice and no-choice conditions were alternated within a multielement and reversal design. During the choice condition, participants completed a simple free-operant response and were allowed to choose a reinforcer out of an array of two at each scheduled delivery. Five reinforcers were available from which the therapist randomly chose two to present as a choice each time the schedule requirement for reinforcement was met. During the no-choice conditions, the therapist delivered a single reinforcer for responding. The authors attempted to control for preference by yoking the items delivered during the no-choice condition with those selected by participants in the immediately proceeding choice session. That is, the order in which the therapist delivered a specific reinforcer coincided with the order selected by participants in the previous choice session. Results for each participant indicated that there were no consistent differences in response rates between the choice and no-choice conditions. In other words, under these circumstances, choice did not appear to enhance participants’ responding. Similar to problems in detecting differences in constant versus varied reinforcers, the authors suggested that access to choice might not affect response rates when highly preferred reinforcers are used across both conditions and that access to highly preferred stimuli rather than choice per se may be more influential when establishing rates of responding. Several other researchers have also suggested that high
preference items may have a greater influence on response rates than the format in which reinforcers are presented (Bowman et al., 1997). In this study, the therapists yoked reinforcers in the no-choice conditions with those selected in the choice conditions in an attempt to control for the potentially confounding effects of preference. However, it is unlikely that yoking procedures could fully equate preferences across these two conditions. For example, unless participants reliably chose the same pattern of reinforcer selection, it is unlikely that yoking procedures during no-choice conditions would mimic what participants would choose again if given another opportunity to choose.

Specifically, the sequence of choices that an individual chooses at one moment in time does not necessarily equate with the sequences they choose in subsequent opportunities. Another potential explanation for the similar rates of responding across conditions is the single-operant format.

Some researchers have argued that single operant paradigms might not be as sensitive as concurrent operant arrangements when evaluating response rates. However, as previously discussed, concurrent operant arrangements only inform researchers about a particular individual’s preference for one condition over the other. The single operant format allows researchers to evaluate a particular variable in conditions that are more similar to those present in a typical learning environment. That is, clinicians and educators rarely offer choices of two or more concurrently available tasks associated with distinct reinforcers (DeLeon, Frank, Gregory, & Allman, 2009). Thus it seems important to continue to evaluate any initial comparisons of two or more variables via a single operant paradigm in order to determine how response rates are affected under common
learning contexts. Results such as those obtained by Lerman et al. (1997) using a single operant format are useful to help establish the boundaries of the effectiveness of choice.

Several researchers have proposed that the positive effects of choice on responding may be due to at least three mechanisms. First, choice of reinforcers may accommodate momentary changes in reinforcer preference (DeLeon et al., 2001; Graff & Libby, 1999). Research has shown that preference for reinforcers can sometimes fluctuate (Carr, Nicholson, & Higbee, 2000; Hanley, Iwata, & Roscoe, 2006). A study by Hanley, Iwata & Roscoe (2006) revealed that while the majority of the participants (80%) had relatively stable preferences across a three to six month time frame, changes in preferences could be generated systematically via naturally occurring changes in establishing operations or conditioning histories. While preferences may be relatively stable across time, preferences do have the potential to shift at least temporarily and researchers have attempted to find ways to accommodate these momentary shifts in preference in order to maintain responding.

Within the choice literature specifically, several studies have demonstrated that an individual’s preferences often change (Dyer, 1987, Fisher et al., 1997; Kennedy & Haring, 1993; Roane, Vollmer, Ringdahl, & Marcus, 1998). In a study by Graff and Libby (1999) for example, researchers compared pre-session choice (where only one participant selected reinforcer was delivered throughout a session) and within-session choice (participants could choose from an array of reinforcers at each scheduled delivery). Results indicated that in a single operant paradigm, providing within-session choice produced higher rates of responding, on average, for three out of four participants
than rates during pre-session choice conditions. In sessions where both pre-session and within-session choice were concurrently available, all four participants allocated significantly more responding to the within-session choice option. An examination of consumption data revealed that all participants varied at least to some degree, their choices among reinforcers during all within-session choice conditions (both single and concurrent operant conditions), indicating that their preferences changed within-session. By allowing choice of reinforcers at each scheduled delivery, participants were able to select those that were presumably the most preferred at that particular moment in time.

A second possible mechanism behind the effects of choice is that choice in itself may function as a reinforcer (Schmidt, Hanley, & Layer, 2009; Sellers et al., 2010; Tiger et al., 2006). Using a concurrent operant design, Tiger and colleagues (2006) found that for some typically developing preschoolers, choice was more preferred even when the choice option resulted in the same reinforcer as the no-choice option. More specifically, some participants preferred to choose from several identical reinforcers than to receive the same reinforcer delivered by the experimenter. In a follow-up study, Schmidt et al. (2009), attempted to control for the amount of stimuli present in the choice and no-choice options. For the task associated with choice, participants were allowed to select one of five identical reinforcers. The task associated with experimenter choice also presented five identical reinforcers however, the experimenter selected and delivered the reinforcer. For five of the six participants, the choice task was preferred over the no-choice and control tasks indicating that even when reinforcers are identical and quantity is controlled across choice and no-choice contexts, individuals often prefer to choose their reinforcer over an experimenter selected reinforcer. Even within the basic animal literature, the
opportunity to choose has been shown to be preferred over no-choice conditions. For example, Catania and Sagvolden (1980) found that pigeons preferred a condition in which they could respond on three available keys to a condition in which only one key was available, even though both conditions produced the same-programmed reinforcement contingencies.

A third purported mechanism of choice is that choice may impose a form of stimulus variation. In the aforementioned study, Graph and Libby (1999) noted that participants varied their selections among reinforcers when they were allowed to choose a reinforcer at each scheduled delivery. The authors suggested that the within-session choice conditions allowed for reinforcer variation and that stimulus variation rather than choice may have been responsible for differences between the pre-session choice condition and within-session choice condition. Although the authors were not specifically evaluating stimulus variation and choice, it raises important questions as to the underlying mechanisms behind choice. Specifically, does choice serve as a form of stimulus variation?

Fisher et al. (1997) noted in their discussion that choice may reduce decrements in responding associated with repeated exposure to a single reinforcer. The authors stated that when individuals alternate their choice among reinforcers, this could also attenuate decrements in responding similar to that associated with reinforcer variation. In another investigation DeLeon et al. (2001) suggested that for individuals who demonstrate shifts in preference, choice may be a useful method for accommodating these changes. Similar to Fisher et al., the authors proposed that choice increases reinforcer variation, which can
reduce rapid decreases in responding. However, the notion that reinforcer choice functions as a form of reinforcer variation has not been empirically evaluated.

**Reinforcer Variation and Choice**

Based on previous research, it appears that both reinforcer variation and reinforcer choice can maintain responding better than either a single constant reinforcer or no-choice conditions. While several authors have suggested that choice and reinforcer variation produce the same effects on responding, no studies have explicitly isolated these variables and compared responding associated with varied reinforcers (experimenter selected) versus choice of reinforcers (participant selected).

One potential difference between the mechanisms of reinforcer choice versus varied reinforcers is the predictability of reinforcer sequences. When an experimenter varies reinforcers, they typically present them in a random sequence (unpredictable) (Egel, 1980, 1981; Milo et al., 2010; Najdowski et al., 2005). In contrast, under conditions of choice, participants would theoretically be able to predict what reinforcer they will select prior to making a response. Predictability of consequences may be related to the effects of different schedules of reinforcement. In predictable sequences where each response is reinforced, each individual reinforcer is also on a fixed ratio schedule of reinforcement (e.g., 1, 2, 3, 1, 2, 3...). In unpredictable sequences where each response is reinforced, each individual reinforcer is presented in a random order that resembles a variable ratio schedule of reinforcement (e.g., 2, 1, 3, 2, 3, 1...). If predictability of reinforcers was an underlying mechanism of the relative success of
varied reinforcers, it is possible that varied reinforcers could produce higher rates of responding than in choice conditions.

Although previous research suggests that choice may indeed be as effective as reinforcer variation on response rates during single operant arrangements, further research should be conducted to control for potentially confounding variables such as exposure across these two conditions and specifically isolate choice as the only differential variable when compared to experimenter-varied reinforcers. Also, no research to date has explicitly evaluated the relative preference for choice of reinforcers versus experimenter-varied reinforcers.

Additional research on choice and reinforcer variation would also contribute to the growing emphasis on the rights of individuals with disabilities to make choices. Bannerman, Sheldon, Sherman, and Harchik (1990) highlighted several important points in regards to the personal rights of people with disabilities and the opportunity to choose. First, research has shown that individuals with disabilities tend to prefer the opportunity to choose and that failing to present opportunities to choose may infringe on an individual’s personal liberties. Second, teaching individuals to make even basic choices amongst stimuli such as reinforcers, activities, and tasks is a critical component of educational and life skills programming and facilitates the development of more complex choice-making skills. Nevertheless, some procedures may facilitate skill acquisition better than others. In the case of choice and experimenter-varied reinforcers it has yet to be determined whether these procedures produce similar rates of responding or if one procedure is superior to the other. If both procedures produced similar results or if choice was found to produce higher response rates, clinicians should be encouraged to offer
choice for the aforementioned reasons. If however experimenter-varied reinforcers were found to facilitate responding better than choice, clinicians would have to determine which procedure produces the most benefit to the client. If a critical skill needs to be developed, varying reinforcers might be more important than offering the opportunity to choose reinforcers. If, however, response rates for a particular skill were less relevant, incorporating choice may be more desired, especially if clinicians are interested in placing a greater emphasis on increasing the personal dignity and self-determination of individuals with disabilities.

**Purpose**

The purpose of the present study was to evaluate how reinforcer choice affects free-operant response rates as compared to experimenter-varied reinforcers by addressing some of the limitations of previous research. Specifically, the primary focus of this experiment was to further examine the third purported mechanism associated with the beneficial effects of choice: imposed reinforcer variation. A secondary purpose was to evaluate participant preference for the opportunity to choose reinforcers relative to experimenter-varied reinforcers. The specific questions addressed were:

1. To what extent does the opportunity to choose among three moderately preferred reinforcers presented in an MSWO format affect free-operant response rates as compared to experimenter variation of the same three reinforcers in preschoolers with autism?

2. To what extent do preschoolers with autism demonstrate a preference for a condition where they can choose among three moderately
preferred reinforcers presented in an MSWO format versus experimenter variation of the same three reinforcers?
CHAPTER II

METHODS

Participants, Setting and Materials

Three male students attending a university-based preschool for children with autism participated. Arlo, Elliott, and Jack were four years of age and each had a diagnosis of autism. Additionally, the participants were highly motivated by edible items as indicated by interviews with preschool staff, had no dietary restrictions (e.g., gluten or casein-free diets) and were able to complete a simple free-operant response (e.g., moving a block from one basket to another) without assistance.

We conducted all sessions in the individual participants’ work cubicles within the preschool classroom. A small table and two or three chairs were present as well as one or two data collectors. Materials included task related stimuli (e.g., baskets and blocks), edible items, colored placemats (on which to place edibles) to assist with discrimination between conditions, and a low preference leisure item (present throughout all sessions).

Graduate research assistants or undergraduate research assistants (under supervision of graduate assistants) conducted all sessions. Sessions were conducted one to six times per day, three to five days per week. All sessions were 5 min in length. To control for extra-experimental influences, edible reinforcers were not used during participants’ other training programs prior to experimental sessions and researchers requested that parents withhold the same edibles used in the study prior to arriving at school. Additionally, all sessions were conducted at approximately the same time each
Participants continued to receive edible items as part of their academic sessions after all experimental sessions had been conducted for that day.

**Response Measurement and Interobserver Agreement**

The primary dependent measure was the frequency of free-operant responses expressed as responses per minute. For each participant, the free operant task consisted of moving a single block from one basket to another. During all experimental sessions attempts to complete more than one response before consuming the edible reinforcer were blocked in order to control for the number of reinforcers available for consumption at a particular moment in time. Data were also collected on specific moderately preferred (MP) item selection (MP 1, MP 2, MP 3) as well as consumption of edibles (item passed plane of the participants’ lips). All data were collected via handheld devices, using Instant Data software, for all measures.

Interobserver agreement (IOA) was assessed by having a second observer simultaneously but independently score behaviors during 35.5%, 35.5%, and 35% of all sessions for Arlo, Elliott, and Jack, respectively. Using the Instant IOA software program, IOA was calculated by dividing the number of agreements in frequency of responses between observers in each 10 s interval by the number of agreements plus disagreements in the same interval. They were averaged across all intervals and multiplied by 100%. Overall target response IOA scores for Arlo, Elliott, and Jack were 94.3% (range 82.2% to 100%), 92.9% (range 82.8% to 100%) and 91.2% (range 75.8% to 100%), respectively. Overall participant item selection IOA scores were 93.3% (range 80.6% to 100%), 89.9% (range 77.4% to 100%), and 91.1% (range 77.4% to 100%) for
Arlo, Elliott, and Jack, respectively. Overall IOA scores for consumption were 90.7% (range 74.1% to 100%) for Arlo, 87.7% (range 75.8% to 96.7%) for Elliott, and 89% (range 64.5% to 100%) for Jack.

Preference Assessments

Preference for 16 food items reported to be preferred during informal interviews with each participant’s preschool case manager were assessed using the paired-stimulus preference assessment method (Fisher et al., 1992). Participants were allowed to sample each edible item prior to the start of the assessment. Each edible was paired with each of the other items in a random order and attempts to select both items were blocked. Moderately preferred (MP) items were designated as those items selected between 40% and 60% of available trials. A total of three MP items were selected for each participant for use throughout the study. Higher preference items were not used to reduce the likelihood that those items would overshadow potential differences in responding across conditions (Lerman et al., 1997; Sellers et al., 2010).

An 8-item paired-stimulus preference assessment (Fisher et al., 1992) was conducted to identify low preference tangible items. Participants were allowed to engage with each item prior to the start of the assessment. Each leisure item was paired once with each of the other items in a random order. Attempts to select both items were blocked. The lowest ranked item with which the participant still engaged was selected as the low preference leisure item. We included the leisure item across all conditions as a concurrent alternative to control for responding in the absence of programmed reinforcement contingencies (Daly et al., 2009). In other words, the inclusion of the
leisure item was a control intended to prevent participants from responding during baseline conditions simply because there was no other alternative activity available.

An independent observer collected data across 100% of all paired-stimulus preference assessments. Interobserver agreement was assessed by comparing the scores of the primary data collector and the independent observer for each selection made by the participant and dividing the number of agreements by the total number of selections made, multiplied by 100%. The mean IOA scores for the 16-item paired-stimulus preference assessments across participants was 99% (range 96% to 100%). The mean IOA scores for the eight-item paired-stimulus preference assessments across participants was 97.8% (range 89.2% to 100%).

**Treatment Integrity**

A second observer simultaneously but independently scored experimenter behaviors via handheld devices using Instant Data software during 36.2%, 36%, and 35% of all experimental sessions for Arlo, Elliott, and Jack, respectively. Specifically, treatment integrity data were taken on reinforcer delivery (experimenter placing reinforcer on placemat following participant emission of target response). During varied reinforcer sessions, data collectors indicated the specific edible delivered (MP 1, MP 2, or MP 3). Using the Instant IOA software, treatment integrity was calculated by dividing the number of agreements in frequency of responses between observers in each 10 s interval by the number of agreements plus disagreements in the same interval. They were averaged across all intervals and multiplied by 100%. Overall treatment integrity scores
for Arlo, Elliott and Jack were 95.9% (range 87.1% to 100%), 90.7% (range 72.04% to 100%) and 92.9% (range 77.4% to 100%), respectively.

Preexperimental Procedures

In order to identify an appropriate free-operant task and make necessary modifications to experimental procedures, a series of preexperimental test sessions took place for Arlo and Elliott. The primary purpose of these test sessions was to assess whether a particular task could be completed without additional prompts and to ensure that the task itself was not reinforcing. For Arlo, a total of six 5-min sessions were conducted and were identical to baseline procedures described below. A total of two tasks and two identically ranked leisure items were evaluated prior to proceeding to formal baseline sessions.

Although Elliott did not require more than one task to be evaluated, his responding indicated that the instructions “you can work, play, or do nothing” were exerting a form of stimulus control over his behavior, not related to the experimental conditions (he would immediately pick up the low preference leisure item after the verbal instructions, regardless of the contingencies in place). A total of 13 5-min sessions were conducted (7 under baseline conditions, 6 under single item reinforcement conditions). During two of the single item test sessions, the therapist blocked Elliott from picking up the leisure item at the beginning of the session. Elliott then began responding on the task at high rates for the remainder of the session. However, without this initial blocking at the beginning of the session, he continued to pick up the leisure item after hearing the verbal instructions. During the final two single item test sessions, we omitted the verbal
instructions. Responding on the task increased and he no longer picked up the leisure item when reinforcement contingencies were in place. After this series of test sessions, Elliott began formal baseline sessions in the absence of verbal instructions (he continued to receive preexposure prompts according to the condition descriptions below, prior to each session).

Research Design

The effects of reinforcer variation and reinforcer choice on response rates were evaluated via a variation of an A-B-A-C-A-C-A-B reversal design, with the sequence of treatment conditions counterbalanced across participants. Baseline phases were conducted between all treatment conditions and the order of experimental conditions was counterbalanced within and across participants to control for sequencing effects. A final condition compared the relative response rates obtained during choice and varied reinforcer conditions when presented in a concurrent operant arrangement for Arlo and Elliott. Table 1 depicts the order of experimental conditions for each participant (excluding additional baseline conditions between experimental conditions) and the colors of the materials (colored block during baseline, colored block and colored placemat for all other conditions) associated with each condition.

Experimental Procedures

Baseline

The purpose of this condition was to assess baseline rates of responding in the absence of any programmed contingencies. Pre-exposure consisted of a model prompt to
Table 2

Order of Conditions and Corresponding Colors for Each Participant

<table>
<thead>
<tr>
<th>Participant</th>
<th>Arlo</th>
<th>Elliott</th>
<th>Jack</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conditions Order and Associated Color</td>
<td>Baseline - Yellow</td>
<td>Baseline - Blue</td>
<td>Baseline - Green</td>
</tr>
<tr>
<td></td>
<td>Single - Green</td>
<td>Single - Red</td>
<td>Single - Yellow</td>
</tr>
<tr>
<td></td>
<td>Varied - Red</td>
<td>Choice - Yellow</td>
<td>Varied - Blue</td>
</tr>
<tr>
<td></td>
<td>Choice - Blue</td>
<td>Varied - Green</td>
<td>Choice - Red</td>
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<tr>
<td></td>
<td>Choice</td>
<td>Varied</td>
<td>Choice</td>
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<td>Varied</td>
<td>Choice</td>
<td>Varied</td>
</tr>
<tr>
<td></td>
<td>Concurrent</td>
<td>Concurrent</td>
<td>Varied</td>
</tr>
</tbody>
</table>

engage in the task. Arlo and Jack were given the brief instruction “you can work, play or do nothing.” Elliott was not provided verbal instructions throughout the experiment for the reasons outlined above. No programmed consequences were provided for responding during baseline.

**Single MP Items**

This condition assessed rates of responding for each MP item to confirm that these stimuli functioned as reinforcers and that they produced relatively similar response rates. Prior to the start of each session, participants were pre-exposed to the free-operant task and associated consequences via a model prompt. Instructions identical to those in baseline were given to Arlo and Jack. Each MP item was assessed separately in a single constant reinforcer format within a multielement design. A single reinforcer was delivered throughout an entire session on an FR 1 schedule of reinforcement. The order in which items were assessed across sessions was random with a minimum of four
sessions per item. Items were placed on a colored placemat by the experimenter after each reinforced response to equate reinforcer delivery across conditions and to assist with discrimination.

**Reinforcer Variation**

This condition was designed to assess rates of responding when the three MP items were varied in a predetermined, random order. Participants were pre-exposed to the task and associated consequences three times (in order to experience all three edibles) prior to the start of each session. For Arlo and Jack, the research assistant gave brief instructions identical to those in previous conditions. Following a response, the research assistant selected and placed one of the three MP reinforcers on a colored placemat using an FR 1 schedule of reinforcement. All three edibles were delivered during a session and the order of MP items was random and programmed beforehand such that no single reinforcer was delivered more than twice in a row. To achieve this, a list was created based on all possible combinations of the numbers 1, 2, and 3, which represented the three MP items. Those combinations were then randomly and equally distributed onto two different spreadsheets (see Appendix C). The research assistant selected reinforcers based on these spreadsheets in a descending order, across sessions. Once both spreadsheets had been exhausted, the research assistant started over using the first spreadsheet.

Due to a considerable increase in Jack’s problem behavior that developed during the course of the study, several minor modifications were made for him starting at session 69. Prior to the start of the first session of each day, research assistants provided Jack
with noncontingent attention for approximately 3 to 5 min. The purpose of this was to reduce a suspected motivating operation for attention. In addition, the research assistant blocked attempts by Jack to throw materials during sessions by holding one hand approximately 12 cm above the baskets and block. No contact between the research assistant’s hand and Jack’s hand occurred unless he raised the block or baskets high enough to throw. If this occurred, the baskets were re-positioned on the table and/or the block was removed from his hand and placed back into one of the baskets. This procedure did not interfere with his ability to start or stop task responding.

**Choice**

The purpose of this condition was to evaluate response rates when participants were given a choice of reinforcers following each response. Prior to each session, the experimenter pre-exposed the participants to the associated consequences as described below. Brief instructions identical to those in previous conditions were given to Arlo and Jack, prior to the start of each session. Following each response, MP items were presented in an MSWO format. After the first response, the experimenter presented all three MP items on a colored placement in a random order. The participant was allowed to select one of the three items as a reinforcer. The second response resulted in the experimenter placing the remaining two MP items on the placemat in a random order and allowed the participant to choose one item as a reinforcer. The third response resulted in the experimenter placing the last remaining item on the placemat as the reinforcer. This sequence repeated until the session terminated. The purpose of the within-session MSWO format was to equate exposure to each reinforcer with the varied reinforcer condition and to prevent participants from repetitively choosing the same item.
Preference for Reinforcer Choice and Reinforcer Variation

This condition examined the relative reinforcement effects of both choice and reinforcer variation on responding. A concurrent operant arrangement was employed to determine whether participants demonstrated a preference for either participant choice of reinforcers or experimenter-varied reinforcers. Two identical task options (i.e., moving a block between two baskets) were available concurrently and each was associated with either choice of reinforcers or experimenter-varied reinforcers. For Arlo, tasks were available on the same table, equally spaced apart. Arlo sat in a chair positioned between the two tasks. For Elliott, procedures were identical to those used for Arlo for the first two sessions (one table). However, modifications were made in an attempt to address potential stimulus control issues unrelated to the experimental conditions (he would only respond on the task on the right side of the table which was always prompted last during preexposure). Subsequent sessions for Elliott consisted of the two tasks placed on two separate tables equidistant apart. This modification required him to walk to each task rather than sit in a chair. Prior to the beginning of each session the research assistant preexposed the participants to each task and its associated consequences. After preexposure, Elliott was physically guided back between the two tables. For Arlo, brief instructions stating that he could “work on either task, play, or do nothing” were given prior to each session. Each task was associated with the same color (colored placemats, colored blocks) as established in previous conditions in order to assist with discrimination between available consequences. Additionally, the research assistant changed the placement of each condition’s task (right versus left) after every session in an attempt to
control for side biases. Each participant’s low preference leisure item was also available throughout all sessions.

Jack did not participate in the concurrent operant phase of this study due to excessive absences from school and a considerable increase in problem behavior over the course of his participation in this research (e.g., throwing materials on the ground and/or at research assistants). This increase in problem behavior is suspected to have contributed at least in part, to increases observed during regular instructional time in the preschool. Based on his record of attendance and increasing levels of problem behavior, it was determined that additional research sessions could potentially exacerbate problem behavior and further reduce time spent receiving critical instruction.
CHAPTER III

RESULTS

Figure 1 depicts the results of the 16-item and 8-item paired-stimulus preference assessments for each participant. Items selected for use as the moderately preferred edible stimuli and the leisure item are highlighted for each participant. For Arlo, the three moderately preferred items were selected 53.3%, 46.6% and 40% of available trials (Life® cereal, Cheez-it Grips® and marshmallows, respectively). Elliott required a second 16-item preference assessment because the first assessment did not reveal three MP items within the required range. Based off the second assessment, the three moderately preferred items for Elliott were selected 46.6%, 46.6% and 40% of available trials (tortilla chip, Honey Nut Cheerio® and M & M®, respectively). A second, 8-item preference assessment was also conducted for Elliott to identify a new low preference leisure item for use after preexperimental test sessions indicated the originally selected leisure item may have competed with reinforcement contingencies. For Jack, all three moderately preferred items (Vanilla wafer, Potato chip and Cheez-it Grips®) were selected 46% of available trials.
Figure 1. Results of the 16-item paired-stimulus preference assessment for edibles and the 8-item paired-stimulus preference assessment for leisure items for each participant. Gray bars represent items selected for use as moderately preferred edibles and the low preference leisure item.
Figure 2 presents the data, in responses per minute, for each participant during baseline, single, varied and choice conditions. Arlo’s data are presented in the upper panel of Figure 2. During baseline, Arlo engaged in variable rates of responding with a decreasing trend across exposures ($M = 1.8$ responses per minute). When MP items were presented in a single format, responding increased confirming that the MP items identified in the paired-stimulus preference assessment functioned as reinforcers ($M = 3.5, 3.7$ and $2.6$ responses per minute for MP 1, MP 2, and MP 3, respectively). During the first exposure to the varied condition, Arlo engaged in moderate levels of responding ($M = 3.6$ responses per minute). In the initial exposure to the choice condition, responding initially decreased across the first six sessions. However, levels of responding increased above those seen during the varied condition in the last 3 sessions ($M = 3.9$ responses per minute). After a brief return to baseline, this level of responding was maintained during the second exposure to the choice condition ($M = 5.5$ responses per minute).

During the second exposure to the varied condition, levels of responding were initially similar to those obtained in the first exposure. However, a decreasing trend in responding developed ($M = 3.1$ response per minute). Overall, the highest rates of responding for Arlo were observed during the choice condition ($M = 4.5$ responses per minute) as compared to the varied condition ($M = 3.3$ responses per minute) although these differences were not large.

Rates of responding for Elliott are displayed in the middle panel of Figure 2. Across all baseline exposures, responding was stable at zero or near-zero levels ($M = 0.01$ responses per minute). During the single MP items condition, responding increased for
each MP item when target responses were reinforced ($M = 9.5, 9.1$ and $8.9$ responses per minute for MP 1, MP 2, and MP 3, respectively). When Elliott was first exposed to the choice condition, responding was stable ($M = 8.6$ responses per minute).

During the first exposure to the varied reinforcers condition, Elliott engaged in a level of responding similar to that seen in the previous choice condition although rates were somewhat more variable ($M = 8.9$ responses per minute). After a brief return to baseline, rates of responding under the varied condition continued at a similar level though a slight decreasing trend developed ($M = 8.5$ responses per minute). During the second exposure to the choice condition, Elliot’s response rates were more variable than those observed during the first exposure. However, the overall level of responding did not change ($M = 8.5$ responses per minute). No considerable differences in response rates were observed between choice ($M = 8.5$ responses per minute) and varied reinforcer conditions ($M = 8.7$ responses per minute).

Jack’s results are displayed in the lower panel of Figure 2. For Jack, rates of responding across baseline exposures were low ($M = 0.1$ responses per minute). During the single items condition, Jack’s rate of responding increased above baseline levels but was variable across the three items ($M = 6.2, 10.3$ and $8.9$ responses per minute for MP 1, MP 2 and MP 3, respectively). During the initial exposure to the varied condition, his rates of responding were also somewhat variable but remained within a relatively stable range during the last ($M = 7.9$ responses per minute).
Figure 2. Rates of responding during baseline, single, varied and choice conditions for each participant.
In the first exposure to choice, Jack also engaged in variable rates of responding with the overall level above that seen in the first varied condition ($M = 10.2$ responses per minute). A second exposure to the choice condition resulted in a slightly lower level of responding, similar to the level seen in the initial varied condition ($M = 7.0$ responses per minute). The final exposure to the varied condition resulted in high variable rates of responding with a level above that demonstrated in the first varied exposure ($M = 9.9$ responses per minute). However, response rates were comparable to those seen during the first choice exposure. Although Jack’s responding was highly variable across all conditions, there were no substantial differences in response rates across all exposures to the varied and choice conditions ($M = 8.9$ and $8.8$ responses per minute, respectively).

The data reported in Figure 3 reflect responses per minute for Arlo and Elliott when two identical tasks associated with either choice or varied reinforcers were available under the concurrent operant arrangement. Response rates for Arlo did not indicate a preference for either condition and an overall decreasing trend developed ($M = 1.4$ and $1.1$ responses per minute for varied and choice conditions, respectively).

Elliott’s responding under the concurrent operant condition did not reveal a preference for one condition over the other. Instead, he consistently responded to the task on the right side (one table) or on the left table (two tables), regardless of the associated condition. Rates of responding were comparable across sessions and conditions ($M = 3.2$ and $M = 3.7$ responses per minute for varied and choice, respectively).
Figure 3. Responses per minute during the concurrent operant condition for Arlo and Elliott. Data for Elliott represent responses made when both tasks were on one table and responses made when tasks were on separate tables.
CHAPTER IV

DISCUSSION

The primary purpose of this study was to determine whether there would be differences in responding between a condition in which an experimenter selected and varied three moderately preferred reinforcers and a condition in which the participant was able to choose from the same three reinforcers in an MSWO format. A secondary purpose of this study was to evaluate whether participants would demonstrate a preference for one procedure over the other. In general, results did not indicate differential rates of responding between conditions of choice and varied reinforcers for any of the participants. An additional assessment of preference between choice and varied reinforcers evaluated with two participants suggested that they favored both conditions equally.

Results of the present study could be viewed several ways. One interpretation of our results is that choice may not enhance responding as compared to varied reinforcers delivered by an experimenter. Similar to the conclusions described by Lerman et al. (1997), this finding further clarifies additional parameters under which the effects of choice are not likely to be observed. In this case, when preference was held constant across conditions and exposure to each reinforcer was equated, choice did not improve responding. A second interpretation however, might be that choice may not suppress or interfere with responding. This understanding supports the integration of even simple choice making opportunities that can be embedded within interventions, without concerns of lowered rates of responding. Similar conclusions can be drawn from the results of the
concurrent operant assessment. Specifically, overall responses allocated between the choice and varied reinforcer conditions were more or less equal. This suggests that any effects associated with choice may not influence preference for choice relative to experimenter-varied reinforcers under these specific experimental conditions. Despite finding no major differences between choice and varied reinforcers across single and concurrent operant assessments, these outcomes should not imply that choice is the same as reinforcer variation nor should they imply that choice is unimportant to individuals. For instance, the opportunity to choose may be more influential when presented under more naturally occurring conditions such as choice of reinforcers during typical instruction. Consistent with outcomes of prior research (e.g., Brigham & Sherman, 1973; Fisher et al., 1997) choice could also be more preferred to a no-choice option (such as varied reinforcers) when the two conditions are more discernable or result in qualitatively different reinforcers.

**Limitations**

Although choice and varied reinforcer conditions did not differentially affect responding in the current study, these results are only preliminary and should be interpreted with caution. One potential reason for undifferentiated responding in both the single and concurrent operant assessments is a lack of discrimination between the varied and choice conditions. Despite attempts to enhance discrimination such as assigning colors to each condition and preexposure before each session, it is possible that participants may not have been able to discriminate subtle differences between conditions. Although the investigational procedures implemented were not intended to
control for *all* variables related to choice, the experimental methods may not have adequately captured potential differences that exist between choice and reinforcer variation. For example, the MSWO format was included within the choice procedure in an attempt to control for exposure to reinforcers across conditions. While this allowed control over one potential confound, the procedure excluded a potentially influential aspect of choice; the ability to choose the same reinforcer repeatedly. It is possible that differential responding could emerge when choice opportunities are less restricted.

Responding under the varied and choice conditions also did not differ from those obtained during the single item condition. While previous research has shown that reinforcer variation and choice procedures can enhance responding compared to single items (single constant reinforcers/no-choice), there were no substantial differences in response rates between the single MP items condition and the varied and choice conditions. However, we caution against a direct comparison between these conditions in this investigation. The single items condition was only intended to confirm that the three MP items served as reinforcers, and not as a comparison for response rates observed in the subsequent varied and choice conditions. Nevertheless, it is possible that there may be other factors responsible for the similar response rates across all three conditions. For example, we used moderately preferred stimuli that were selected between 40% and 60% of available trials in the preference assessment. Previous researchers often define moderately preferred stimuli using higher ranges or rankings and the use of lower preference items in this study may have contributed to the comparable response rates (i.e., floor effect).
In this investigation, rates of responding were used as a measure of reinforcer effectiveness. Although common, response rates are not the only means by which these two conditions could have been evaluated. For example, it is possible that differences may exist based on the persistence of responding (e.g., how long an individual will respond under each condition). In other words, while overall rates of responding may be similar, participants may have responded for different lengths of time if the sessions were longer (e.g., 30 min). Along these lines, results could have varied based on other factors such as different schedules of reinforcement, type of tasks, response effort of task, and additional types of reinforcers to name a few. Lattal, Reilly, and Kohn (1998), for example, found responding was more persistent under interval schedules of reinforcement compared to ratio schedules in both rats and pigeons.

Outcomes of this investigation may have also been influenced by participant behavior under the control of extra-experimental variables. Elliott required several modifications to address what appeared to be patterned responding unrelated to experimental contingencies. When first assessing responding in the preexperimental test sessions, verbal instructions appeared to have exerted faulty stimulus control that interfered with the reinforcement contingencies associated with the task. While he always completed the preexposure responses, he would immediately pick up the low preference leisure item after verbal instructions. Once verbal instructions were eliminated, his responding appeared to come under the control of the reinforcement contingencies. However, his responding under the concurrent operant arrangement also appeared to be under faulty stimulus control. When both tasks were on the same table, he responded exclusively to the task that was prompted last (on the right) during
preexposures. When tasks were on two different tables, he responded exclusively to the task that was prompted first (on the left) during preexposures. Despite attempts to address this problem, equal response allocation to the two tasks across sessions was probably due to something other than preference.

One interesting finding was that during all choice sessions, Elliott always chose reinforcers in the exact same order (MP 1, MP 3, MP 2, MP 1, MP 3, MP 2...). No identifiable patterns were found for Arlo or Jack. In Elliott’s case, this predictable pattern did not appear to influence response rates between the two conditions. However, it remains unclear if predictable choice patterns under other circumstances would differentially affect responding.

Jack’s emergence in problem behavior over the course of the study also required minor modifications to the experimental procedures implemented during the final varied condition. Although blocking procedures did not appear to affect free-operant responding, it is certainly possible that the increasing trend in this last phase was related to a reduced opportunity to engage in problem behavior.

**Implications and Conclusions**

This investigation was designed to evaluate prior research hypotheses proposed by DeLeon et al. (2001), Fisher et al. (1997), and Graff and Libby (1999) who implicated similarities between conditions of choice and reinforcer variation. Specifically, this study extends the literature on choice, reinforcer variation and reinforcer effectiveness by directly comparing these two procedures associated with enhanced responding. By addressing some of the limitations of previous research, preliminary results suggest that
when preference is held constant and exposure to reinforcers is equated, choice and reinforcer variation procedures similarly affect responding on a free-operant task.

Based on outcomes and limitations associated with this study, further evaluations and comparisons of choice and reinforcer variation seem warranted. Future researchers may want to address other variables that could highlight conditions under which choice and reinforcer variation procedures produce differential results. One suggestion would be to evaluate this procedure using different schedules of reinforcement. It is possible that higher response requirements could reveal differences in both overall response rates as well as preference for each procedure. Break points identified via progressive ratio schedules may also be useful in identifying subtle differences concerning choice and reinforcer variation.

In terms of the mechanisms of choice, results support the notion that the effectiveness of choice procedures may be due at least in part, to exposure to a variety of reinforcers which in turn may mimic the effects of similar reinforcer variation procedures. That is, similar rates of responding obtained in the choice and reinforcer variation conditions may indicate that choice procedures function similarly to reinforcer variation procedures due to reduced exposure to any single reinforcer. Regarding the other purported mechanisms of choice, it is possible that these choice procedures may have also accounted for momentary changes in participant preference. However, the reinforcer variation procedures would appear to be equally effective at attenuating momentary changes in preference. In terms of choice as a reinforcer, our results do not indicate that had any additive effects under these experimental parameters. However, this study did not directly examine or manipulate underlying mechanisms and conclusions are
only speculative. Future researchers may want to conduct more detailed analyses to identify the underlying mechanisms, commonalities and differences behind choice and reinforcer variation as well as defining additional parameters that may or may not influence the effectiveness of reinforcers.

Both choice and reinforcer variation have been demonstrated in previous research to address loss of reinforcer effectiveness and show that some individuals may demonstrate preferences for these conditions (Bowman et al., 1997; Egel, 1980, 1981; Fisher et al., 1997; Milo et al., 2010). Results of the present study may indicate that choice and reinforcer variation procedures function similarly. Nevertheless, it is important to reiterate that these results should not be misinterpreted to mean that choice and reinforcer variation are indeed one in the same or that the opportunity to choose is of no great concern (and subsequently reduced or eliminated in naturalistic environments). Instead, our results identify additional parameters in which choice and reinforcer variation are likely to produce similar results. It is essential that researchers continue to evaluate and understand the underlying mechanisms and conditions under which these two procedures may differ.
REFERENCES


APPENDICES
APPENDIX A

16-Item Paired-Stimulus Preference Assessment Data Sheet
16-Item Paired-Stimulus Preference Assessment

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Therapist: _______________  Time: ____________

Observer: ____________  Prim/Reli

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APPENDIX B

8-Item Paired-Stimulus Preference Assessment Data Sheet
8-Item Paired-Stimulus Preference Assessment

Participant: ______________________  Date: _____________

Therapist: ______________________  Time: _____________

Observer: _____________ Prim/Reli

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APPENDIX C

Sample Varied Reinforcer Data Sheets
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APPENDIX D

Letter of Information
LETTER OF INFORMATION

Evaluating the Effects of Reinforcer Choice and Reinforcer Variation on Response Rates of Children with Autism

Introduction/Purpose Professor Thomas S. Higbee and doctoral student Alice Austin in the Department of Special Education and Rehabilitation at Utah State University are conducting a research study to find out more about the effects of different reinforcers and choice on how young children with autism respond to requests to complete tasks. You have been asked to take part because your child is currently enrolled as a student in the ASSERT Preschool Program. There will be approximately 3-5 participants in this research.

Procedures If you agree for your child to be in this research study, the following will happen: Sessions will be held while your child is at the ASSERT preschool. Your child will be prompted to engage in a simple task such as tracing letters. Each time he or she does the task, he/she will be given a small food item that we identify as something he/she likes. Sessions will be conducted three to five times per day and are 5 minutes in length. It is estimated that research sessions will continue for approximately 1-2 months.

New Findings During the course of this research study, you will be informed of any significant new findings (either good or bad), such as changes in the risks or benefits resulting from participation in the research, or new alternatives to participation that might cause you to change your mind about continuing in the study. If new information is obtained that is relevant or useful to you, or if the procedures and/or methods change at any time throughout this study, your permission to continue participating in this study will be obtained.

Risks Participation in this research study involves minimal risk. There are no physical risks associated with participation in this study. However because this research involves experimental procedures there may be some unknown risks. To minimize the effects of unforeseeable risks, your child will be under the direct supervision of an instructor and/or researcher at all times during the procedures.

Benefits There may or may not be any direct benefit to you from these procedures. The investigator, however, may learn more about reinforcer variation as compared to reinforcer choice and your child’s preference for either procedure. The information gained from this study may benefit other students, teachers, and researchers in the future.

Explanation & offer to answer questions Dr. Higbee and/or Alice Austin have explained this research study to you and answered your questions. If you have other questions or research-related problems, you may reach Professor Higbee at (435) 797-1933, or Alice Austin at (435) 797-2381.

Payment/Compensation There is no payment or compensation associated with participation in this project.

Voluntary nature of participation and right to withdraw without consequence Participation in research is entirely voluntary. You may refuse to participate or withdraw at any time without consequence or loss of benefits. You may be withdrawn from this study without your consent by the investigator if your child moves from the area, is frequently absent, or chooses not to participate during the research sessions. Your decision to have your child participate, or not, will in no way affect your
LETTER OF INFORMAITION
Evaluating the Effects of Reinforcer Choice and Reinforcer Variation on Response Rates of Children with Autism

child's placement or services at ASSERT. Furthermore, ASSERT services will not be affected should you choose to withdraw your child at any time.

Confidentiality Research records will be kept confidential, consistent with federal and state regulations. Only the investigators will have access to the data that will be kept on a password-protected secure server. Personal, identifiable information and data will be kept for a period not to exceed 3 years, and will then be destroyed (shredded). If the results of this study are published, no names will be used that will reveal the identity of the participants.

IRB Approval Statement The Institutional Review Board for the protection of human participants at USU has approved this research study. If you have any pertinent questions or concerns about your rights or a research-related injury, you may contact the IRB Administrator at (435) 797-0567 or email irb@usu.edu. If you have a concern or complaint about the research and you would like to contact someone other than the research team, you may contact the IRB Administrator to obtain information or to offer input.

Investigator Statement "I certify that the research study has been explained to the individual, by me or my research staff, and that the individual understands the nature and purpose, the possible risks and benefits associated with taking part in this research study. Any questions that have been raised have been answered."

Thomas S. Higbee
Principal Investigator
(435) 797-1933
tom.higbee@usu.edu

Alice Austin
Student Researcher (or Co-PI)
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CURRICULUM VITAE
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Major: Disability Disciplines-Applied Behavior Analysis Specialization
Degree: Doctorate of Philosophy, (in progress)
Advisor: Thomas S. Higbee, Ph.D., BCBA-D

University of Houston - Clear Lake - Houston, TX
Major: Behavioral Science-Psychology, Applied Behavior Analysis Sub Plan
Degree: Master of Arts, August 2007
Advisor: Dorothea C. Lerman, Ph.D., BCBA-D

Washington State University - Pullman, Washington
Major: Psychology
Degree: Bachelor of Science, May 2004

Professional Certifications

November 2007  Board Certified Behavior Analyst (BCBA™)

Professional Experience

August 2010 to present  Davis County School District (via Utah State University)  Kaysville, UT
Behavior Analyst
Position duties include designing and maintaining a model ABA-based preschool classroom for children with autism. Specific responsibilities include staff training, designing and supervising curriculum development, designing behavior intervention plans and parent training and consultation.

May 2010 to present  Bear River Activity Center  Logan, UT
Behavior Analyst
Position duties include reviewing and updating client behavior intervention plans as well as writing monthly progress reports.

January 2009 to present  STE Consultants  Berkeley, CA
Behavior Analyst
Position duties include reviewing behavioral interventions for individuals with developmental disabilities under the care of California state regional centers.
Professional Experience continued

October 2007 to present  Chrysalis  
**Behavior Analyst**
Position duties include conducting functional behavior assessments, designing behavioral interventions, staff training, and writing monthly progress notes for individuals with disabilities living in a group home setting.  
Logan, UT

August 2007 to present  ASSERT Preschool - Utah State University  
**Graduate Assistant**
Position duties include case management and curriculum development for preschool students with autism, staff supervision and training, parent training, private family consultation and public school consultation for children with autism.  
Logan, UT

March 2006 to July 2007  The Mental Health and Mental Retardation Authority of Harris County  
**Behavior Therapist**
Position duties include conducting functional behavior assessments, implementation of behavior analytic procedures to reduce problem behavior, and parent training.  
Houston, TX

June 2006 to July 2007  University of Houston - Clear Lake  
**Teacher Trainer**
Provided training to teachers of children with developmental disabilities within local school districts. Training focused on skill acquisition in areas such as preference assessments and various prompting procedures.  
Houston, TX

September 2005 to July 2007  University of Houston - Clear Lake  
**Research Assistant**
Position duties include providing reliability data collection for graduate assistants, completing functional analyses within local school districts, and formalizing and implementing research designs involving observer accuracy and teacher training.  
Houston, TX

November 2005 to May 2006  Private home  
**Behavior Therapist**
Position duties include implementing an intensive home-based behavior analytic program with a 9-year-old child with autism.  
League City, TX
Professional Experience continued

January 2003 to May 2003  Washington State University  Pullman, WA
**Research Assistant**
Position duties included recruitment of participants and data management for research in infant temperament.

August 2002 to May 2003  Washington State University  Pullman, WA
**Research Assistant**
Position duties included human and animal operant research, data analysis, and formalizing and implementing a pilot research design.

Teaching Experience

Fall 2009  Utah State University  Logan, UT
**Instructor**
SPED 6700
Graduate level course in single-subject design

Spring 2009  Utah State University  Logan, UT
**Teaching Assistant**
SPED 5050
Undergraduate course in applied behavior analysis (Part II)

Fall 2008  Utah State University  Logan, UT
**Teaching Assistant**
SPED 5010
Undergraduate level course in applied behavior analysis (Part I)

Summer 2003  Washington State University  Pullman, WA
**Teaching Assistant**
PSYCH 384
Undergraduate level course in Perception

Professional Presentations


Professional Presentations continued


Professional Presentations continued


Mullen, S. K., Sevin, B. M., & Keyl, A. A. (2007, March). *To Ask or Not to Ask: Establishing Discriminated Manding Following FCT*. Poster presented at the annual Meeting of the Texas Association for Behavior Analysis, Dallas, TX.


Manuscripts Under Review


Publications

Non-Refereed Publications


Editorial Experience

2010  Guest Reviewer  
Journal of Applied Behavior Analysis

2009  Guest Reviewer  
Journal of Applied Behavior Analysis

Membership in Professional Associations

Association for Behavior Analysis International  
Association for Professional Behavior Analysts  
California Association for Behavior Analysis  
Utah Association for Behavior Analysis

Scholarships and Awards

February 2010  California Association for Behavior Analysis  
Julie Vargas Award (for student research in the field of behavior analysis)

Fall 2007 to Spring 2008  Utah State University  
Presidential Fellowship Award

Spring 2007  University of Houston – Clear Lake  
University Endowment

Fall 2005 to Fall 2006  University of Houston – Clear Lake  
Dollars for Scholars