5-2016

# Consideration of Reinforcer Magnitude with Respect to Preference and Reinforcer Assessment Outcomes

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**Consideration of Reinforcer Magnitude with Respect to Preference and Reinforcer Assessment Outcomes**

by

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A Thesis

Submitted to the Graduate Faculty of

St. Cloud State University

in Partial Fulfillment of the Requirements

For the Degree of

Master of Science

in Applied Behavior Analysis

May, 2016

Thesis Committee:

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**Abstract**

This study examined the correspondence between preference for systematically differing magnitudes of edible stimuli and relative progressive ratio (PR) breakpoints. A primary MSWO preference assessment was used to rank eight different edible items. Next, a secondary MSWO preference assessment determined preference for 0.5, 2, and 10 g of HP and LP items. Following a baseline phase, 0.5, 2, and 10 g of both the HP and LP items (i.e., six stimuli total) were tested individually under PR reinforcer assessment administrations. In contrast to previous research, there was not a direct correspondence between preference and PR breakpoints. In addition, HP stimuli did not consistently produce higher breakpoints when compared to LP stimuli, irrespective of magnitude.

**Acknowledgements**

First, I would like to thank my advisor, Dr. Benjamin N. Witts for his interminable support and guidance. I owe gratitude to the research assistants without whom this research would not have been possible. This experience has been humbling in that I was reminded that the assistance and advising I received was imperative to a successful master’s thesis.

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## Chapter 1: Introduction and Literature Review

Behavior analytic treatment, with its emphasis on individualized therapy, has been accepted as the most effective treatment for Autism Spectrum Disorder (ASD). Specifically, therapy derived from behavior analysis has been empirically proven to be successful in reducing maladaptive behavior and teaching communicative and adaptive skills associated with ASD (U.S. Department of Health and Human Services, 1999, pp. 163-164). One important way that treatment can be individualized is by identifying ways to promote optimal teaching conditions in coordination with idiosyncratic learner preference. Teaching, in a behavioral application, involves not just the response, but the outcome that will serve to help acquire and generalize that response. Creating a teaching environment that facilitates the most rapid acquisition rates and behavior that is resistant to change involves providing a reinforcing outcome for proper responding, especially if that reinforcement is positive, rather than negative. Positive reinforcement involves providing access to a stimulus following correct responding, resulting in an increased probability that responses from that behavior class will be observed under similar future conditions. However, arbitrarily-selected stimuli or ‘common-sense reinforcement’ (e.g., money, praise) may not function as reinforcement for every individual. Therefore, reinforcement must be determined on an individual basis if treatment is to be most effective.

Identifying items that might serve as reinforcement is an important component of any behavior analytic treatment that seeks strengthens deficit skills. There are two complementary analyses that help to identify stimuli to use as reinforcers in treatment: preference assessments—used to identify putative reinforcers—and reinforcer assessments—which capture the extent to which preferred items function as reinforcement. Put simply, preference assessments measure how much the learner “likes” an object, food, or activity when compared with other items and reinforcer assessments indicate how hard he or she will work for said outcomes. Although explicit testing of reinforcer efficacy appears more frequent in research than practice, preference assessments are a key component in behavior analytic treatment (Graff & Karsten, 2012). As preferences are prone to change, it is recommended that preference assessments are conducted frequently (e.g., daily; Graff & Karsten, 2012).

## Preference Assessments

Several indirect and direct methods exist to identify putative reinforcers for research and practice. Indirect methods involve asking the caregiver or staff member questions to determine preferred and non-preferred stimuli. Thus, indirect measures are verbal reports of potential responses to stimuli, and not an actual observation of stimulus-response interaction. Direct methods are different from indirect methods as they measure responding to stimuli directly (i.e., approach or engagement responding). When designing behavioral interventions or research studies, clinicians and researchers must select an assessment method or combination of assessment methods for identifying stimuli for use as reinforcement. Deciding which method to employ likely involves consideration of time commitment, potential problem behavior that might arise from the assessment, and assessment validity.

### Indirect Methods

Examples of indirect methods include the reinforcer checklist (Matson, Bielecki, Mayville, Smalls, Bamburg, & Baglio, 1999) and Reinforcer Assessment for Individuals with Severe Disabilities (RAISD; Fisher, Piazza, Bowman, & Amari, 1996). Matson et al. (1999) created a reinforcer checklist to help identify potential reinforcers for individuals with developmental disabilities. In an initial experiment, the researchers interviewed direct support staff to determine which items would be considered preferred for individuals residing in a residential treatment facility. To be included in the study, staff members had to have worked with the client of interest for at least 6 months. Items were included in the subsequent reinforcer checklist if they were identified as preferred in the structured interviews for at least 25% of the individuals with developmental disabilities. The resulting checklist contained 60 potential reinforcers. A second experiment evaluated internal consistency, inter-rater reliability, and test-retest reliability which were all favorable.

Similar to the reinforcer checklist developed by Matson et al. (1999), the RAISD (Fisher et al., 1996) was created to identify potential reinforcers by interviewing caregivers. Researchers were interested in comparing preference identification using a standard list of reinforcers to a list generated by caregivers. An initial phase involved asking caregivers to rank items from a standard list (i.e., a list that was not individualized) of potential reinforcers used in prior investigations by Fisher, Piazza, Bowman, Hagopian, Owens, and Slevin (1992) and Pace, Ivancic, Edwards, Iwata, and Page (1985). Caregivers also were asked to identify items that they suspected to be highly preferred for the individual in a structured interview. The caregivers were given general domains such as visual, edible, and social to aid in item identification. To compare the two methods, caregivers were asked to rank order the items from both the standard list and those nominated during the interview after which direct preference assessments were conducted for both groups of stimuli. Finally, a reinforcer assessment compared the top preferred items from the standard and caregiver generated lists. Fisher et al. (1996) found that the RAISD identified more items that functioned as reinforcers when compared to ranking items on a standard list.

Similar investigations examining the efficacy of indirect methods have found that caregiver report may not be a reliable assessment of preference for individuals with developmental disabilities (e.g., Green, Reid, Canipe, & Gardner, 1991; Parsons & Reid, 1990). Such studies have evaluated correspondences between caregiver report using surveys and results from direct preference assessments and found that caregiver reports did not reliably match results from formal preference assessments.

Many techniques to identify stimuli preference are available for use by clinicians and researchers. Indirect and direct methods may be used in unison or in combination; however, the predictive validity of indirect methods alone has not been demonstrated empirically (Hagopian, Long, & Rush, 2004). Therefore, reliance on indirect methods such as caregiver interviews alone is cautioned, warranting reliable procedures that directly measure learner responding.

**Direct Methods**

Direct preference assessments that measure approach responses include the single-stimulus method (SS; Pace et al., 1985), paired-stimulus method (PS; Fisher et al., 1992), the multiple-stimulus with replacement method (MS; Windsor, Piche, & Locke, 1994), and the multiple-stimulus without replacement method (MSWO; DeLeon & Iwata, 1996). Preference assessments that measure engagement with stimuli include the free operant method (FO; Roane, Vollmer, & Ringdahl, 1998) and the single-stimulus engagement method (SSE; DeLeon, Iwata, Conners, & Wallace, 1999). Preference for stimuli incorporated into preference assessments are typically arranged on a preference hierarchy that illustrates relative preference. Often, stimulus preferences are referred to as high-preference (HP), moderate-preference (MP), and low-preference (LP), depending on their relative preference ranks after the assessment.

In the SS method, each stimulus object is presented alone (Pace et al., 1985) and the dependent measure is an approach response.  A trial involves presenting a single stimulus, allowing the participant a predetermined time to approach the stimulus, and providing access to the stimulus given an approach response. The assessment trial is terminated upon failure to respond within the specified interval. For each stimulus tested in a SS preference assessment, an initial probe is conducted (as was just described) and is followed by a prompted trial to ensure the learner is familiar with the stimulus. Stimuli are presented on a specified number of trials with the order of presentation counterbalanced.

Stocco, Thompson, and Rodriguez (2011) investigated whether learner behavior with respect to the presentation of leisure items influenced the way that teachers present and remove items. Stocco et al. (2011) used the SS method to determine preference for stimuli for 4 males diagnosed with autism, two of which demonstrated restricted interests for leisure items and the other two showed an equivalent interest for several items (i.e., distributed interests). The SS preference assessment involved presenting each leisure item singly to the learner for 30 s, three to five times across sessions, and recording positive (i.e., positive language and stimulus approach) and negative (i.e., challenging behavior, negative language, and stimulus avoidance) behavior. The authors used the outcomes from the SS preference assessment to select four items for each participant for use in the second phase of the study. Specifically, two items likely to evoke positive behavior (i.e., stimuli that would be putative reinforcers) and two likely to produce negative behavior (i.e., stimuli that would be putative punishers) were chosen for the participants with restricted interests. For the participants with distributed interested, four items that were relatively equivalent in terms of preference were selected for the second phase of the investigation.

In a second phase, Stocco et al. (2011) instructed teachers to present the selected stimuli to the participant one at a time for 10 min to evaluate how learner responding to stimuli may influence the way items are presented by teachers. An analysis of teacher behavior was made by comparing the nature of item presentation for learners with restricted interested to learners with distributed interests. Put simply, researchers were interested in evaluating whether teachers would present items more likely to evoke problem behavior less frequently for learners with restricted interests and used individuals with distributed interests as a control. Teacher behavior was influenced by differential responding to stimuli such that items with greater engagement were presented for longer durations and items associated with more negative behavior were presented less. Finally, items were presented more equally for the learners who demonstrated distributed interest (Stocco et al., 2011). The investigation conducted by Stocco and colleagues demonstrates the effective use of the SS method for identifying differential preference for leisure items.

An alternative to the approach-based SS assessment is to measure engagement duration. The SSE creates a preference hierarchy in which the stimuli engaged with for the longest period is considered the most preferred (DeLeon et al., 1999).

Zhou, Goff, and Iwata (2000) investigated the efficacy of increased response effort (i.e., wearing a sleeve that increases force required to bend one’s arm) to decrease hand mouthing for females with developmental disabilities. Zhou et al. (2000) used a variation of the SSE preference assessment to identify HP items to have available during baseline and treatment phases. The preference assessment involved presenting each stimulus from an array of 15 leisure items singly for 2 min across three trials. A preference hierarchy was developed by comparing relative engagement durations with the highest engagement duration being most preferred. When the sleeve was worn, participants manipulated HP objects more and engaged in hand mouthing less, demonstrating the effectiveness of increased response effort in the reduction of hand mouthing. Although there was no comparison of the efficacy of having HP rather than LP stimuli available for object manipulation as a treatment component, Zhou et al. (2000) incorporated the SSE method for identifying preference and used HP items identified in an effective treatment for self-injury.

Learners are given access to all stimuli tested simultaneously in the FO method (Roane, Vollmer, & Ringdahl, 1998). To determine relative preference, duration of stimulus engagement is recorded. For example, if an individual played with a toy airplane, puzzle, and balloon for 80%, 10%, and 10% of intervals, respectively, the toy airplane would be said to be the highest preferred item in the array.

Sautter, LeBlanc, and Gillett (2008) conducted FO preference assessments and analyzed play interaction under conditions involving items varying in preference for five boys with autism and their siblings. The FO preference assessment involved two sessions testing six stimulating items (e.g., items with flashing lights) and two sessions testing six developmental toys (e.g., a ball and bat). Preference for stimuli were determined based off duration of engagement with each stimulus and determined which toys would be used in the subsequent sibling play analysis. HP stimulating, LP stimulating, HP developmental, and LP developmental toys were compared independently by placing the object in a room with the child with autism and his sibling and instructing the typically-developing sibling to attempt to play with his or her sibling with autism. Sautter et al. (2008) found that LP toys, either stimulating or developmental, resulted in more appropriate sibling interaction (e.g., interactive or parallel play) and less nonfunctional behaviors (e.g., stereotypy). By conducting FO preference assessments, the researchers were able to demonstrate that LP rather than HP toys were better suited for cooperative play.

In the PS method, two stimuli from an array of several stimuli are present together concurrently until each stimulus has been paired with all of the other stimuli at least once (Fisher et al., 1992). Once a choice is made between the two stimuli, the learner is given access to the selected stimulus. For example, if the trial consists of a chocolate chip and a cracker, the participant is allowed to consume the edible he or she selects for that trial. In this case, if the participant chooses a chocolate chip, the chocolate chip is said to be preferred over a cracker. If there is no response to either stimulus presented, it is indicated that the learner does not prefer either stimulus.

In an evaluation of preference for edible and leisure items for 14 elderly individuals with dementia, Ortega, Iwata, Nogalez-González, and Frades (2012) used a PS preference assessment and subsequent reinforcer assessment to identify preference for and reinforcing efficacy of leisure and food items for individuals with varying severities of dementia. Ortega et al. (2012) tested four edible and four leisure items after allowing the participants to sample each item by using PS methods. The position of each stimulus was counterbalanced by repeating the assessment and changing the position (i.e., right or left) for each stimulus. Upon selection of the item, the participants were allowed to eat the item (edible items) or gain access for 30 s (leisure items). Reinforcer efficacy was tested differently across participants following the PS preference assessment. Ortega et al. (2012) demonstrated the predictive validity of the PS preference assessment by identifying items that would serve as reinforcement for individuals with dementia.

Rather than presenting items singly or in pairs to identify preference, an array of several items can be presented concurrently in direct preference assessments. In the MS (Windsor, Piche, & Locke, 1994) method, the entire stimulus array is presented to the individual and each stimulus is available across a predetermined number of trials. Relative preference is determined by comparing the frequency of selection for each stimulus in the MS method.

Wilder, Register, Register, Bajagic, and Neidert (2009) decreased the frequency of rumination maintained by automatic reinforcement by delivering preferred flavored sprays on a fixed-time (FT) schedule for an adult diagnosed with autism and mental retardation. To identify preference for different flavored sprays, Wilder et al. (2009) employed a MS preference assessment which involved placing barbeque, birthday cake, and apple pie flavored spray next to three chairs and allowing the participant sample each while sitting in the respective chair. A selection between the three flavors was indicated by the participant sitting in the associated chair. A total of 28 preference assessment trials were conducted with the order of the chairs rotated after 14 trials to account for position bias. Rumination was successfully decreased by delivering the HP spray identified from the MS preference assessment on a FT schedule of reinforcement (Wilder et al., 2009).

One potential problem with the MS method is that the HP stimulus might be selected exclusively, thus preventing any true hierarchy from developing (e.g., DeLeon, Iwata, & Roscoe, 1997; Roscoe, Iwata, & Kahng, 1999). The MSWO (DeLeon & Iwata, 1996) method corrects for this potential stimulus bias by removing the selected stimulus from the remaining trials. Compared to the MS, the MSWO is briefer, as it ends after each stimulus has been selected, and has better predictive validity than the MS method (DeLeon & Iwata, 1996).

Schiff, Tarbox, Lanagan, and Farag (2011) used a MWSO preference assessment to determine items to use as reinforcement in a treatment package alongside stimulus fading to increase compliance with medication acceptance for a boy diagnosed with autism. Schiff et al. (2011) conducted a MSWO preference assessment prior to each treatment session and used the HP stimulus as reinforcement for correct responding to the current stimulus fading condition. Stimulus fading began with tolerating an empty syringe being present and ultimately lead to acceptance of medication delivered by the participant's mother. A brief, MSWO preference assessment was successful in indentifying preferred items that functioned as reinforcement in a treatment package used to increase medication acceptance (Schiff et al., 2011).

Several methods used to identify preference for stimuli to use as reinforcement in behavioral interventions have been reviewed. Preference assessments that directly measure learner responding to stimuli vary with respect to presentation format (i.e., presenting stimuli singly or concurrently) and type of response measured (i.e., approach or engagement). Strengths and limitations of each of the reviewed procedures vary as a function of the nature of presentation; therefore, special consideration for the type of procedure to use should be made on a case-by-case basis.

**Strengths and limitations.** The presentation format involved with the various preference assessment techniques are associated with different patterns of responding, problem behavior, and resulting preference hierarchies.

***Time.*** Some preference assessments are lengthier than others due to the number of required trials. When compared to the MS, MSWO, SS, SSE, and FO approaches, the PS method requires the most time to conduct. The MSWO is a similarly valid preference assessment that is likely briefer than the PS and MS methods but requires more time than the FO method, depending on the number of trials one elects to run using the MS and FO methods (Karsten, Carr, & Lepper, 2011). For example, testing preference for a 10-item stimulus array would require 45 trials for the PS method, 9 trials for the MSWO method, and a researcher or clinician-determined number of trials for the MS, SS, SSE, and FO approaches.

***Position biases.*** When stimuli are presented to the learner concurrently (e.g., on a tabletop, horizontally), the learner might select a stimulus according to its position on the surface rather than the stimulus properties. This selection pattern is called position bias and has been shown to be a barrier in clinical investigations (e.g., discrimination training; Green, 2001). The PS, MS, and MSWO methods are more susceptible to developing positional bias than SS or FO approaches because stimuli are presented together, often on a table in front of the learner. Put simply, the learner may select the stimulus presented on the right side across all trials. Further, positional bias may occur depending on the presentation nature used in the FO method. For example, one may place items side-by-side in the room (i.e., susceptible to positional bias) or may place items evenly in a circular fashion in the learner's natural environment (i.e., unlikely to produce positional bias). If position bias occurs when assessing an individual's preference, selecting the FO or SS methods, using prompting strategies to orient the learner to all stimuli (i.e., require an observing response), or changing the presentation format (e.g., presenting stimuli vertically rather than horizontally) is warranted (Karsten et al., 2011).

***Problem behavior.*** Preference assessments that remove stimuli after a trial run the risk of evoking problem behavior, particularly those whose problem behavior might be tangibly maintained. In the MSWO format, the stimulus is removed after it is selected. Likewise, the PS method requires that a new set of stimuli are presented each trial. Problem behavior is less probable using the FO method as all stimuli are concurrently available (Roane et al., 1998).

***Utility.*** Some preference assessments are more amenable to developing hierarchies than others. Generally, the PS and MSWO methods illustrate relative preference with respect to all stimuli tested as the presentation format involves stimulus comparison for all stimuli given that a selection is made on each trial. Specifically, the HP stimulus (i.e., the stimulus with the longest engagement or most approach responding) is not available across all trials, generating a hierarchy also containing MP and LP stimuli. The MS and FO methods may mask preference for

MP and LP items that might serve as reinforcement as the highest preferred item is available across all trials. Repeating the FO assessment in the absence of the HP stimulus may be a viable solution to an incomplete preference. The SS method might have no discriminative value if the participant moves toward all (or a majority of) the items (Hagopian et al., 2001).

Thus, even though Kang, O’Rielly, Giulio, Falcomata, Sigafoos, and Xu (2013) found the PS and MSWO methods do a better job of identifying items that will serve as reinforcement based on their preference hierarchies in a review of the preference assessment literature, the strengths and weaknesses just described require researchers and practitioners to take care in deciding what method to use. To this end, Karsten et al. (2011) developed a model to help practitioners make informed decisions regarding which preference assessment method to employ based off the strengths and limitations described above. This decision-making model is presented as a flow chart that one navigates by considering variables such as time commitment and the preference hierarchy produced. Put simply, it is optimal to select a method that requires the least amount of time and produces the most information regarding relative preference. They recommend beginning with the MSWO method as a default strategy and using the FO or PS method if the stimulus array includes large objects or activities. Given high rates of problem behavior or a tendency to select items in a given position, Karsten et al. (2011) suggested that the administrator either use behavioral strategies (e.g., extinction of problem behavior during assessment) to achieve success or change the type of preference assessment used.

Once an appropriate assessment procedure has been implemented, the next step is to verify reinforcer efficacy (Karsten et al., 2011). Unfortunately, preference assessments alone do not test whether items identified as preferred will function as reinforcers, warranting the need to test their reinforcing effects systematically (Piazza, Fisher, Hagopian, Bowman, & Toole, 1996).

## Reinforcer Assessments

Preference assessments are used to identify items that are likely to serve as reinforcement in behavioral interventions. For example, a stimulus that is selected on 80% of opportunities would be ranked higher than a stimulus that was selected on 5% of opportunities. In this example, the stimulus selected 80% of opportunities would be suspected to be a more “effective” reinforcer. However, preference assessments alone do not determine reinforcement effects. Therefore, the predictive validity of preference assessments must be verified by empirically testing reinforcement efficacy through reinforcer assessments. Reinforcer assessments test the assumption that higher preferred items will produce more responding, faster acquisition rates, and support greater response effort when compared to the lower-ranked stimuli (Hagopian et al., 2004). There are several approaches to testing reinforcer efficacy, including various presentation formats (i.e., assessing one or multiple stimuli at a time) and schedules of reinforcement (e.g., fixed or progressive schedules).

### Single and Concurrent Arrangements

Reinforcer assessments can be conducted by providing stimuli singly (single operant arrangement) or simultaneously (concurrent operant arrangement). Under a single operant arrangement, the learner is required to respond according to a specified reinforcement schedule to gain access to the stimulus. For example, a child might gain access to a toy car for 30 s after he or she strings 5 beads. When compared between stimuli tested singly, those that produce more responses are said to be more reinforcing.

Concurrent operant arrangements provide the learner with a choice between two tasks that correspond to different putatively-reinforcing stimuli (Tiger, Toussaint, & Roath, 2010). An example might include a learner who is given the choice to string 5 red beads for access to a cracker or string 5 blue beads for access to raisins. In addition to various arrangements that can be used to test reinforcer efficacy, different schedules of reinforcement may be evaluated.

**Schedule Requirements**

Identifying reinforcer efficacy requires a response to access reinforcement, otherwise called a schedule requirement. For example, a researcher or clinician might provide a cracker for stringing 1 bead (fixed-ratio [FR] 1) or every 5 beads (FR 5). Reinforcer assessments have traditionally used a dense schedule of reinforcement (i.e., FR 1) and a response that readily exists in the individual's repertoire (i.e., low effort response) to avoid confounding variables inherent with a difficult response or requiring an excessive number of responses to access reinforcement (Roane, Lerman, & Vordran, 2001). Contrary to prior cautionary advice suggesting that a low effort response and dense schedule of reinforcement are optimal, researchers have more recently identified that reinforcer efficacy may vary differentially with respect to the response requirement, warranting exploration of intermittent schedules of reinforcement to determine reinforcement efficacy (e.g., DeLeon, Iwata, Goh, & Worsdell, 1997; Tutsin, 1994).

DeLeon and colleagues (1997) found that similarly preferred reinforcers may be equally reinforcing when the response requirement is low, but that effects may be differentiated when the step size increases. Thus, reinforcement efficacy might vary as a function of response requirement. Progressive ratio schedules of reinforcement test the extent to which stimuli can support increased response requirements.

**Progressive ratio.** Schedule requirements that increase within an experimental session are called progressive ratio (PR) schedules of reinforcement (Roane, 2008). The number of responses required to access reinforcement increases after each reinforcer delivery. The systematic increase in response requirement—the step size—can be either geometric or linear.

Geometric progression involves multiplying the response requirement by a constant (e.g., by 2; 1, 2, 4, 8, 16) and linear progression involves adding a constant to the previous response requirement (e.g., by 2; 1, 3, 5, 7; Tiger, Toussaint, & Roath, 2010). Reinforcer assessments under a PR schedule of reinforcement require termination criteria which typically include predetermined session duration or a period of time without responding. Finally, relative reinforcer efficacy is determined by the last completed schedule requirement, otherwise known as a breakpoint (Roane, 2008). Schedule interferences that occur as a result of repeated exposure to the item used as reinforcement can be eliminated by the within-session increase in schedule requirement inherent in PR schedules of reinforcement (Trosclair-Lasserre, Lerman, Call, Addison, & Kodak, 2008). Therefore, researchers or clinicians who are interested in capturing reinforcement effects while avoiding schedule interferences may benefit from using PR schedules of reinforcement.

Roane et al. (2001) evaluated reinforcement effects of similarly preferred stimuli with reinforcer assessments using PR schedules of reinforcement for four individuals with developmental disabilities. The PR response requirement was linear for three of the participants and geometric for the remaining participant. Items similarly preferred tended to produce varying response efforts under PR schedules of reinforcement. In a second experiment, they compared three treatments (i.e., non-contingent reinforcement, differential reinforcement of other behavior, and differential reinforcement of alternative behavior) using the same stimuli tested in the preceding reinforcer assessments. In the first experiment, Roane et al. (2001) found that stimuli that were selected on a similar number of trials in an initial preference assessment produced differential reinforcement effects in a subsequent reinforcer assessment. Further, the second experiment found that stimuli that functioned as more potent reinforcers in the reinforcer assessment (i.e., higher breakpoints) were generally more effective in reducing destructive behavior, irrespective of the treatment type (Roane et al., 2001).

Penrod, Wallace, and Dyer (2008) compared PR schedules of reinforcement under a linear progression to FR 1 schedules of reinforcement for HP and LP stimuli. Penrod and colleagues found that LP stimuli produced similar effects relative to HP stimuli under FR 1 schedules of reinforcement. However, PR schedules produced higher breakpoints in HP stimuli relative to LP stimuli.

In a comparison of single and concurrent operant arrangements using linear PR schedules, Glover, Roane, Kadey, and Grow (2008) evaluated the effectiveness of HP and LP stimuli. Regardless of the arrangement, all participants demonstrated higher response rates for the HP stimuli. In a second experiment, Glover and colleagues yoked the breakpoints for HP and LP stimuli from the first experiment to a FR schedule and found that participants continued to respond more to the HP stimulus when the LP was also available in a concurrent schedule arrangement. In other words, even though it was more effortful to earn the HP stimulus, participants continued to work for it rather than take the easier route and earn the LP stimulus. Returning to single-operant arrangements produced mixed response patterns; some produced maximal response rates for the LP stimulus, whereas others responded minimally (Glover et al., 2008).

Francisco, Borrero, and Sy (2008) evaluated the reinforcing efficacy of HP and LP stimuli (i.e., stimuli selected on 80% and 22% of trials in a PS preference assessment, respectively) in reinforcer assessments under both FR 1 and PR schedules of reinforcement. Similar to the Glover et al. (2008), Francisco et al. (2008) found that LP stimuli served as reinforcement when presented in a single operant arrangement under both FR and PR schedules.

However, contrary to Glover et al. (2008), Francisco et al. (2008) found that LP stimuli served as reinforcement when presented concurrently with HP stimuli under a PR schedule of reinforcement (Francisco et al., 2008).

Call, Trosclair-Lasserre, Findley, Reavis, and Schillingsburg (2012) conducted one PS and daily MSWO preference assessments for 7 individuals with developmental disabilities and compared the outcomes with reinforcer assessments using PR schedules of reinforcement. Call et al. found a slightly stronger concordance between the PS preference assessment and PR schedule of reinforcement; however, there was an overall correspondence with respect to both assessments and relative PR breakpoints meaning that LP stimuli generally resulted in low breakpoints and HP stimuli generally resulted in high breakpoints for both the MSWO and PS preference assessments.

DeLeon, Frank, Gregory, and Allman (2009) demonstrated a direct correlation between preference level and relative breakpoints in an evaluation of the correspondence between PS preference assessments and PR reinforcer assessments. DeLeon et al. (2009) tested HP, moderate preferred (MP), and LP stimuli under PR schedules of reinforcement and found that participants produced greater response rates for HP stimuli than for LP stimuli. There was no baseline phase conducted in this investigation which presents a potential limitation as reinforcement effects are typically inferred from baseline data.

Trosclair-Lasserre et al. (2008) assessed preference for reinforcing efficacy of stimuli found to at least partially maintain problem behavior for four individuals including tangible items and attention. The authors tested preference and reinforcing efficacy of various magnitudes (i.e., small, large, and no reinforcement) for the function based stimuli. The concordance between the initial preference assessment using a concurrent-operant arrangement and subsequent PR reinforcer assessments were evaluated by comparing preference for various magnitudes and relative reinforcer assessment response output. Trosclair-Lasserre et al. (2008) found that preference assessments were predictive of PR reinforcer efficacy such that that when participants preferred longer durations (i.e., high magnitude) over shorter durations of a reinforcer, longer durations produced more work in a PR reinforcer assessment.

Halbur, Linn, and Witts (under review) evaluated college students' preferences for varying magnitudes of pizza using a PS preference assessment and tested reinforcing efficacy in subsequent PR reinforcer assessments. Halbur et al. found a lack of correspondence between preference rank order and reinforcer efficacy using reinforcer assessments under a PR schedule such that rank order derived from the initial preference assessment did not reliably predict PR breakpoints for three individuals.

Investigations involving preference assessments and subsequent reinforcer assessments under PR schedules of reinforcement have found that similarly preferred stimuli have produced differential reinforcement effects under PR schedules and reinforcement-based treatments (Roane et al., 2001), LP and HP stimuli have produced similar reinforcement effects under a dense schedule of reinforcement but HP resulted in higher PR breakpoints than LP stimuli (Penrod et al., 2008), LP and HP stimuli both functioned as reinforcers under single operant arrangements using PR schedules (Francisco et al., 2008; Glover et al., 2008), and responding was allocated to LP stimuli when presented concurrently with HP stimuli in one investigation (Francisco et al., 2008) whereas responding was rarely allocated to the LP stimuli when presented concurrently with HP stimuli in another investigation(Glover et al., 2008). Studies concerned with the predictive validity of preference assessments with respect to PR reinforcer assessments generally found a concordance between preference assessments and PR reinforcer assessments (Call et al., 2012; DeLeon et al., 2009; Trosclair-Lasserre et al., 2008) except when systematically varying magnitudes of an edible reinforcer were tested (Halbur et al.). Research suggests that preference assessments reliably predict reinforcer efficacy under PR schedules of reinforcement except when the stimulus array includes stimuli of unequal magnitudes. PR reinforcer assessment outcomes may be unduly influenced by stimulus magnitude due to repeated stimulus exposure across increasing schedule requirements. Additionally, reinforcement effects vary with respect to environmental influence such as context or stimulus exposure; therefore, preference stability must be given special consideration in an analysis of preference and reinforcer assessment validity.

**Stability**

Hanley, Iwata, and Roscoe (2006) found that preference was relatively stable over a period of 3 to 6 months for 7 of 10 participants. To evaluate stability of preference for items ranked according to a PS preference assessment, the authors conducted an average of 11 preference assessments over a 3 to 6 month period for each participant. Preference assessments were conducted at the same time of the day. For two individuals whose preferences were stable, they conducted either satiation or conditioning procedures to impose environmental conditions that would potentially alter relative preference. The satiation procedure was implemented with the HP items and consisted of a minimum of 2 hour and maximum of 3 hour access to the HP stimulus. Conditioning trials were conducted with LP stimuli and involved pairing the LP items with reinforcement (i.e., praise and edible items).

When combined with the results of similar investigations (i.e., Carr, Nicolson, & Higbee, 2000; Hanley et al., 2006; Mason, McGee, Farmer-Dougan, & Risley, 1989; Zhou, Iwata, Goff, & Shore, 2001), only 40% of individuals demonstrated stable preferences across repeated administrations of preference assessments. Additionally, environmental factors may influence preference (Hanley et al., 2006) and subsequent reinforcement efficacy (Carr et al., 2000). Therefore, it is important to conduct preference assessments routinely or until stability is achieved. Conducting routine preference assessments is particularly important in practice so that an analysis of preference for various stimuli can be made with respect to the treatment goal (e.g., skills in acquisition versus maintaining learned skills). Identifying stability is specifically important for research as a clean analysis should be derived from stable rather than variable data.

An arbitrarily selected number of preference and reinforcer assessment administrations (e.g., three) may not be sufficient to yield representative results. For example, Paramore and Higbee (2005) evaluated the predictive validity of a brief MSWO preference assessment using a reinforcer assessment conducted in a school setting. Items identified as HP, MP, and LP were tested in a reinforcer assessment using an alternating treatments design. Following a baseline phase consisting of no programmed consequences, Paramore and Higbee (2005) delivered the corresponding edible item (HP, MP, or LP, depending on the condition) for three consecutive intervals of on-task behavior. On-task behavior was undifferentiated with respect to the preference level of the stimuli tested initially; however, with repeated presentations of the reinforcer assessment, stability was achieved (i.e., no overlapping data points). Although stability criteria were not explicitly stated in the article, if the authors had terminated reinforcer assessment following 10 rather than 28 administrations, the results would have suggested a lack of concordance between the MSWO and reinforcer assessment outcomes.

In an investigation on the concordance between reinforcing efficacy and preference identified by a PS preference assessment, Lee, Yu, Martin, and Martin (2010) included a specific criterion for stability. Lee et al. (2010) conducted reinforcer assessments on an FR1 schedule using a single operant arrangement until stability was achieved. The stability criterion for the reinforcer assessment was defined as three consecutive sessions with less than 20% variation from the mean response rate for the three data points included. PS preference assessments were conducted once 6 items had been ranked using the results of the reinforcer assessments; PS preference assessments continued until all items had been paired with all other items once, therefore there were no stability criteria for preference assessments. Lee and colleagues (2010) found a near perfect relation between outcomes from an initial reinforcer assessment and subsequent preference assessment for one individual but mixed relation for the other participant.

Stability of preference for stimuli appears to be idiosyncratic; preferences remain very stable over time for some individuals whereas preference may be extremely variable over time for others. Environmental variables (e.g., repeated exposure or lack of exposure) to stimuli have been shown to influence preference and reinforcer efficacy (Hanley et al., 2006), therefore routine preference assessments are recommended for practice. Research investigating the relation between different preference and reinforcer assessments must incorporate stability criteria based on evidence that preference and reinforcing efficacy may be variable for some individuals. Results from research that fails to incorporate a stability measure may be unduly influenced by environmental variables that cause fluctuations in preference for and reinforcing efficacy of stimuli.

## Habituation

Habituation is defined as a decrease in responding to a stimulus following repeated exposure or when a stimulus is presented over a long period of time (McSweeney & Murphy, 2009), and the prevailing understanding of habituation (and sensitization) is limited to reflexes and respondents. However, there is evidence suggesting that habituation might influence operant conditioning through respondent relations inherent in operant behavior. Researchers have gathered evidence supporting the claim that habituation occurs to the sensory properties of stimuli that serve as reinforcement by testing for consistency with respect to Thompson and Spencer's (1996) list of empirical properties of habituation and within session changes in operant responding.

Stimulus specificity is one the empirical properties of habituation (Rankin et al., 2009; Thompson & Spencer, 1966). Testing for stimulus specificity in operant conditioning may involve repeatedly presenting an edible stimulus contingent upon a response within an experimental session and then changing the stimulus available for reinforcement. If responding recovers following the change in stimulus, habituation, rather than satiation, is responsible. Thus, habituation causes stimuli that strengthen behavior through reinforcement to lose reinforcing efficacy due to repeated exposure (McSweeney & Murphy, 2009).

Operant changes in responding consistent with stimulus specificity and habituation were demonstrated in an investigation by Epstein, Saad, Handley, Roemmich, Hawk, and McSweeney (2003). Children were provided access to hamburger pieces for responses on a computer game on a VI 2 min schedule. To test for habituation effects specific to stimulus specificity, the stimulus was changed from hamburger to apple pie after 10 or 11 trials, resulting in an increase in response rate. The within session decrease to repeated exposure to hamburger pieces and subsequent increase in response rate when the stimulus was changed to apple pie suggests that habituation was responsible the inability of hamburger pieces to support the rate of behavior. If satiety variables such as stomach distention were responsible, then providing access to additional edible items would cause further decreases in responding (Epstein et al., 2003; McSweeney & Murphy, 2009).

Habituation and stimulus magnitude may be directly related such that high magnitude stimuli are likely habituated to more quickly relative to low magnitude stimuli. Given our understanding of habituation effects, the operant methods used to conduct preference and reinforcer assessments are potentially flawed. Specifically, there is an assumed equivalence between stimuli tested in preference and reinforcer assessments. Consider that stimulus magnitude changes could sway preference or reinforcement hierarchies when altered. For example, while a high-magnitude (e.g., large) edible might be more preferred than a low-magnitude edible, it may be less effective as reinforcement due to faster habituation or satiation.

Reinforcer assessments using PR schedules of reinforcement might be especially troublesome if stimulus magnitudes are not equivalent. Assessing reinforcer efficacy under PR schedules involves providing a putatively reinforcing stimulus contingent on the completion of a progressively increasing schedule requirement. The final completed schedule requirement, otherwise known as the breakpoint, is used to infer reinforcer efficacy. When compared with a low magnitude stimulus, an equally preferred, high magnitude stimulus would likely produce a lower breakpoint when delivered on a schedule that increases progressively within an experimental session. For example, a child may prefer a 10 g cheese stick over a 2 g cracker but produce more work (i.e., a higher breakpoint) for the 2 g cracker. Therefore, higher preference items may be seen as less “effective” reinforcers using a PR reinforcer assessment.

Additional research is needed to identify the degree of influence that reinforcer magnitude has on the relation between preference and PR reinforcer assessment outcomes. Therefore, the purpose of this study was to extend the research of DeLeon et al. (2009), Halbur et al. (under review), and Trosclaire-Lasserre et al. (2008) to determine the degree to which preferences for systematically differing magnitudes of an identical reinforcer determined by a

MSWO preference assessment (DeLeon & Iwata, 1996) were consistent with relative breakpoints from a PR schedule of reinforcement. Additionally, the current investigation investigated the underlying process responsible for operant changes that occur within an experimental session by conducting a post-assessment test for habituation.

# Chapter 2: Method

## Participants and Setting

Three children diagnosed with autism who received intensive behavior therapy participated in this study. Nicholas was a 5 year old male, Betty was a 3 year old female, and Tyler was a 4 year old male. Sessions were conducted in the client's home or childcare setting. Sessions took place in the late morning or early afternoon, at least 2 hours following their last meal. Additionally, edibles were not used as reinforcement for at least 2 hours prior to each session.

## Materials

Edible items including chocolate chips, red grapes, raisins, chia seed crackers, plentils, chocolate chip cookies, stick pretzels, and baby carrots were used for this investigation. Task materials for the reinforcer assessment included three, 264 cm silk cords (10.5 mm in diameter), three, 264 cm craft cords (6 mm in diameter), colored lacing beads in plastic resealable bags (160.5 cm by 14.9 cm), and a 19 min video outlining the procedures created by the first author. The number of beads in each plastic bag followed a geometric progression such that the beading requirement was multiplied by 2 until 32 beads (i.e., 1, 2, 4, 8, 16, 32). Data collection materials included pens, data sheets, stopwatches, and clipboards.

## Dependent Variable and Agreement Data

The dependent variable for each preference assessment was the order of selection. A *selection* was defined as the participant physically grabbing the edible item and placing it in his or her mouth. A preference hierarchy was created based on the order of selection. For the reinforcer assessment, the dependent variable was the breakpoint of completed responses which was defined as the last completed schedule requirement. The cumulative number of within-session beads strung was also recorded. During baseline sessions a *completed response* was defined as the participant stringing a bead onto the string. For reinforcer assessment sessions a completed response was defined as the participant stringing the number of beads for the PR requirement and consuming the entire associated edible amount. Partially consumed edible amounts were not counted as “completed.” If edibles were only partially consumed, this was noted as an attempt.

Interobserver agreement (IOA) was calculated using the trial by trial method. Sessions were video recorded and a second trained observer collected independent data on approximately 30% of preference, baseline, and reinforcer assessment sessions

**Experimental Design**

Three types of MSWO preference assessments were conducted for each participant (see Procedures for details). The first preference assessment, the ‘primary preference assessment,’ compared eight different stimuli (i.e., different types of foods). Each stimulus tested in the primary preference assessment weighed approximately 2 g, with a tolerance of .2 g. The second and third preference assessments, the ‘secondary preference assessments,’ compared varying amounts of the HP and LP stimuli as determined from the initial preference assessment. Amounts tested in the secondary preference assessments included 0.5, 2, and 10 g of the item. These amounts were determined based off the typical weight of one edible item. For example, one goldfish cracker is about 1.8 g. Therefore, the weight of the median edible item was rounded up to 2 g, the heaviest weight was determined by multiplying that by 5, and the lightest amount was determined by diving the median weight by 5 and rounding up to the nearest half number. A variance of 10% of the total weight of the tested edible item was allowed for each of these weights. For example, weights ranging from 1.8 g to 2.2 g for the median item were acceptable. Each item portion tested was weighed in advance and placed in resealable bags.

Participants also completed a reinforcer assessment for each amount of HP and LP edibles after completing a bead-stringing baseline assessment consisting of three sessions conducted on separate sessions. Each secondary preference assessment and PR reinforcer assessments was conducted in a semi-random order (i.e., no more than 2 consecutive identical assessments) until stability was reached. Stability for preference assessments was defined as 3 consecutive outcomes with no overlapping data points between the HP, MP, and LP stimuli in both the initial and secondary preference assessments. Stability for reinforcer assessments was defined as 3 consecutive outcomes with a tolerance of one breakpoint step of the first of the 3 consecutive steps. For example, breakpoints of 8, 4, and 16 met this stability criterion as 4 and 16 are within one step of the first breakpoint; however, breakpoints of 4, 8, and 16 did not. Next, a habituation test probe was conducted after stability for the final PR reinforcer assessment was met. Finally, high-effort task probes were conducted using the MP stimulus magnitude from both the secondary HP and LP stimuli.

## Procedures

**Research assistant training.** Research assistants were behavior therapists employed by the autism service provider that served the participants in this investigation. Training consisted of initial instruction provided through a 19 min video and subsequent one-on-one meetings (see Appendix A for script). The first author discussed the overall purpose of the study and procedures. In the one-on-one meetings, the first author and research assistants reviewed all data collection materials, response definitions, and procedural requirements. Next, the first author modeled each procedure and data collection. After modeling, the research assistant role played primary and secondary MSWO preference assessments and a PR reinforcer assessment. During role play, the first author acted as the client while simultaneously collecting agreement data and the research assistant acted as the researcher. Following role play, the first author provided performance feedback. Specifically, praise was given on an aspect that was done well and a piece of corrective feedback was delivered. An example of feedback may have been, “You arranged the stimuli perfectly following each trial, but try to avoid making comments after selection so that you do not inadvertently reinforce selections.” Role play continued until the research assistant achieved at least 90% interobserver agreement. Research assistants were considered qualified if interobserver agreement data collected was at least 90%. If a research assistant required more than two role play session to achieve 90%, he/she would not have been included as an assistant; however, each assistant scored 100% reliability in one session.

**Multiple-stimulus without replacement preference assessment.** MSWO preference assessments were conducted using the method described by DeLeon & Iwata (1996). Each assessment began with all eight items arranged randomly in a balanced design in front of the participant such that each stimulus was placed in a line approximately 5 cm apart and within arm’s reach from the participant. To begin each trial, the researcher asked the participant to pick an item. After an item was selected, the participant was permitted to consume the item. Before beginning the next trial, the order of the remaining stimuli was rearranged randomly by changing the position of each of the stimuli. This procedure continued until all items were selected, 30 s without a selection passed, or the participant stated that he or she was done. If no selection occurred within 30 s of the instruction to choose an item, the assessment was terminated and all remaining items were recorded as not selected. The item selected first, fourth, and seventh most often across the final three preference assessment administrations met were identified as HP, MP, and LP, respectively. Attempts to take more than one stimulus were blocked if possible. If the participant successfully selected more than one stimulus, the trial was counted and the trial was represented. In the event that the participant expelled or otherwise did not eat the full portion of the selected stimulus, that item and the remaining items were scored as not selected. Occurrences of problem behavior were responded to according to the client's behavior support plan.

***Primary preference assessment.*** The first MSWO preference assessment incorporated eight different stimuli including chocolate chips, red grapes, raisins, chia seed crackers, plentils, chocolate chip cookies, stick pretzels, and baby carrots. These eight stimuli were presented as described above to produce a preference hierarchy.

***High-preference stimulus preference assessment.*** The highest ranked stimulus among the initial stimulus array was used in subsequent preference assessments. Systematically differing weights of this stimulus were tested in the same fashion as the initial preference assessment. Amounts tested were 0.5 g (small), 2 g (medium), and 10 g (large) of the HP edible.

***Low-preference stimulus preference assessment.*** The lowest ranked stimulus produced from the initial preference assessment was evaluated in another preference assessment in the same way that the HP stimulus was tested.

**Baseline.** During baseline, participants were given string and a bucket containing 63 beads (i.e., the maximum number of beads possible given a breakpoint of 32). The participants were told that they may string as little or as many beads as they like. They were also told that they may quit at any time by telling the researcher, "I'm all done." Baseline sessions were ended according to the following criteria; (1) the participant said that he or she is done, (2) 2 min without stringing a bead, (3) the participant eloped or engaged in challenging behavior, or (4) overall session duration of 30 min.

**Progressive ratio reinforcer assessment.** Reinforcer assessments were conducted using the increasing schedule requirement described above. Each of the three amounts from both of the secondary preference assessments (i.e., HP stimulus and LP stimulus preference assessments; six total) were tested until the criteria for stability were reached within each secondary preference class. The order that each stimulus amount was tested was counterbalanced to control for order effects with the caveat that the same stimulus amount was not tested on more than 2 consecutive assessments.

***Habituation test.*** After the breakpoint and stability criterion was reached for the final secondary reinforcer assessment administration, a test for habituation was conducted. Specifically, the MP item (i.e., $4^{th}$ ranked item) was available contingent on completing the schedule requirement following the breakpoint. The item used to test for habituation effects was equal in weight to the stimulus tested in that session. For example, if 10 g of raisins were tested resulting in a breakpoint of 16 (i.e., they said they were all done after stringing 16 beads and eating the edible item or did not otherwise complete the full 32 bead requirement), 10 g of the MP stimulus was available contingent on the completion of the next schedule requirement. After the breakpoint was met, the researcher said, “Ok, you are all done with (tested edible item), now you can have (MP stimulus) if you string these beads.”

***Effort assessment.*** An evaluation of the effect of high-effort versus low-effort response on reinforcer efficacy was conducted as a probe after each participant met the stability criteria for PR breakpoints. A PR reinforcer assessment probe was conducted with the MP stimulus magnitudes from the secondary HP and LP assessments in a counterbalanced order across participants on consecutive sessions involving a 6 mm diameter crafting cord (i.e., one PR reinforcer assessment for the HP and LP stimuli).

# Chapter 3: Results

## Primary Preference Assessment

Nicholas never selected carrots or plentils during any of the primary MSWO preference assessment administrations. Therefore, the items labeled as HP and LP were items ranked first and fifth. Chocolate chips were labeled as HP and grapes were labeled as LP for Nicholas (see Figure 1 in Appendix A). The order of selection for Betty is illustrated in Figure 2 in Appendix A. Pretzels were labeled as HP and grapes were labeled as LP for Betty as pretzels and grapes were ranked first and seventh, respectively. However, Betty never selected grapes during secondary MSWO preference assessments; therefore, the LP stimulus was re-assigned to plentils, the sixth-ranked item. Chocolate chips and plentils were ranked first and seventh, respectively, for Tyler (see Figure 3 in Appendix A). As such, the HP item was chocolate chips and the LP item was plentils.

## Secondary Preference Assessment

During the secondary MSWO preference assessments, Nicholas consistently selected the 10, 2, and 0.5 g items first, second, and third respectively for both HP (i.e., chocolate chips) and LP (i.e., grapes) items. Therefore, 10, 2, and 0.5 g magnitudes were labeled $HP_M$, $MP_M$, and $LP_M$ (see Figure 4 in Appendix A). Betty met the stability criterion in six HP secondary preference assessment administrations; she selected 0.5, 2, and 10 g first, second, and third for both HP (i.e., pretzels) and LP (i.e., plentils) items (see Figure 5 in Appendix A). Consequently, 0.5, 2, and 10 g magnitudes were labeled $HP_M$, $MP_M$, and $LP_M$, respectively, for both HP and LP stimuli for Betty. Tyler selected 10 g of the HP item (i.e., chocolate chips) first across all secondary preference assessment administrations. Responding for the 2 and 0.5 g stimuli was variable at first and stabilized to selecting the 0.5 and 2 g stimuli second and third for the HP item.

Accordingly, the 10, 0.5, and 2 g HP magnitudes were considered $HP_M$, $MP_M$, and $LP_M$, respectively, for Tyler. The 10, 2, and 0.5 g LP magnitudes were labeled $HP_M$, $MP_M$, and $LP_M$, respectively (see Figure 6 in Appendix A).

**Baseline and Progressive Ratio Comparisons**

Nicholas strung 1 bead across all baseline sessions (*M* = 1). Baseline measurements for Betty were 2, 0, and 1 (*M* = 1). Tyler strung 3, 0, and 1 (*M* = 1.3) beads during baseline sessions (see Table A).

Figure 7 in Appendix A shows the PR reinforcer assessment outcomes for Nicholas. The 10 g HP stimulus produced stable breakpoints of 4, 8, and 4 (*M* = 5.3) for Nicholas. The 2 and 0.5 g HP stimuli resulted in stable breakpoints of 8, 8, and 8 (for 2 g; *M* = 8) and 8, 4, and 4 (for 0.5 g; *M* = 5.3). Stable breakpoints for the LP stimulus were 4, 8, and 2 (for 10 g; *M* = 4.7); 1, 4, and 2 (for 2 g; *M* = 2.3); and 1, 2, and 2 (for 0.5 g; *M* = 1.7).

PR reinforcer assessment results for Betty are depicted in Figure 8 in Appendix A. Betty withdrew assent prior to stability being met for all stimulus magnitudes. Therefore, the 10 and 0.5 g HP stimulus magnitudes did not meet the stability criteria. Breakpoints for the HP stimulus were 0 and 2 (for 10 g; *M* = 1); 1, 2, and 1 (for 2 g; *M* = 1.3); and 4, 2, and 0 (for 0.5 g; *M* = 2). The 10, 2, and 0.5 g LP stimuli produced breakpoints of 0, 1, and 0 (*M* = 0.3); 1, 0, and 0 (*M* = 0.3); and 2, 2, and 2 (*M* = 2), respectively.

Figure 9 in Appendix A illustrates the PR reinforcer assessment outcomes for Tyler. Stable breakpoints for the HP stimulus were 16, 16, and 16 (for 10 g; *M* = 16); 32, 16, and 16 (for 2 g; *M* = 21.3); and 32, 16, and 16 (for 0.5 g; *M* = 21.3). The 10 g LP stimulus resulted in stable breakpoints of 4, 2, and 2 (*M* = 2.7). The 2 and 0.5 g stimuli produced breakpoints of 16, 16, and 16 (*M* = 16) and 16, 32, and 8 (*M* = 18.7), respectively.

**Habituation and Effort Assessment**

The final stability test for Nicholas saw a breakpoint of 8 for the medium HP stimulus for Nicholas. After meeting the breakpoint for the 2 g HP stimulus, Nicholas strung the next schedule requirement (i.e., 16 beads) for 2 g of the MP stimulus.

There are no habituation data for Betty due to assent withdrawal.

The final stability test for Tyler was concluded when the large LP stimulus produced a breakpoint of 2. During this session, Tyler strung 4 beads but did not eat the full 10 g edible item associated with that schedule requirement, resulting in a breakpoint of 2. When given the option to string 8 beads for 10 g of the MP item, Tyler strung the required beads but did not eat the full portion of the MP item.

During the high effort task probes, 2 g of the HP and LP stimuli produced breakpoints of 16 and 4, respectively, for Nicholas.

There are no effort assessment data for Betty because of assent withdrawal.

For Tyler, 0.5 g of the HP and 2 g LP items produced breakpoints of 16 and 8, respectively, during the high effort task probes.

**Interobserver Agreement**

IOA was 100%, 100%, and 86% (range, 75% to 100%) for primary MSWO preference assessments, secondary MSWO preference assessments, and reinforcer assessments, respectively.

# Chapter 4: Discussion

These results provide preliminary evidence supporting the need to consider stimulus magnitude when conducting preference and reinforcer assessments. Clear and consistent preferences for different edible items and for differing magnitudes of identical edible items were captured by incorporating stability criteria into the assessment procedures.

The results of the secondary preference assessment suggest that preference for various magnitudes of edible items is idiosyncratic. One might assume that an individual would like larger over smaller portions of their favorite food (i.e., HP items) and smaller over larger portions of a food they do not care for (i.e., LP items). However, the results of the secondary preference assessment varied across participants. Nicholas preferred the largest magnitude irrespective of stimulus preference, Betty always chose smaller over larger magnitudes, while Tyler consistently chose the largest magnitude first but preference for the remaining magnitudes (i.e., 2 and 0.5 g) differed between the HP and LP stimuli. One potential explanation for the differences found across participants may be that idiosyncratic histories of reinforcement contributed to said selections. For example, eating small portions of food may have been reinforced in some way in Betty’s history.

In addition to comparing preference for differing magnitudes of an identical reinforcer, evaluation of reinforcer effectiveness between HP and LP stimuli, irrespective of magnitude, yielded notable findings. Across all participants, HP stimuli did not generally produce larger breakpoints than LP stimuli (see the secondary vertical axis of Figures 7, 8, and 9 in Appendix A). These results are contrasted from previous research in which HP stimuli produced higher breakpoints than LP stimuli (e.g., DeLeon et al., 2009).

Preference for various magnitudes of edible items did not reliably predict reinforcer effectiveness for two of three participants. For example, Tyler selected 10, 2, and 0.5 g of the LP stimulus first, second, and third, respectively. Therefore, Tyler preferred the largest magnitude (i.e., heaviest weight) most and the smallest magnitude (i.e., lightest weight) least. During PR reinforcer assessments, Tyler produced the most work (i.e., strung the most beads) for the smallest LP magnitude (i.e., average breakpoint of 18.7 for 0.5 g) when compared to largest LP magnitude (i.e., average breakpoint of 2.7 for 10 g). Similarly, preference for stimulus magnitudes did not reliably predict reinforcer effectiveness under PR reinforcer assessments across three of six comparisons (i.e., HP and LP for each participant). In other words, there was no direct correspondence between stimulus rank and PR breakpoints in half of the cases.

In three of the six stimulus comparisons, the medium magnitude stimulus (i.e., 2 g) produced higher average breakpoints than the large magnitude stimulus. In three of the comparisons, the small magnitude stimulus produced identical or higher breakpoints than the large magnitude stimulus. Stimulus magnitude preference did reliably predict reinforcer efficacy for Betty; however, breakpoints were consistently low. As such, although there was a general correspondence between preference for various stimulus magnitudes and PR breakpoints, capturing potential differential reinforcement effects was difficult due to a ceiling effect.

HP items are assumed to produce more responses when compared to LP stimuli. In this investigation, different stimulus magnitudes resulted in unpredictable reinforcement effects within and across participants. For example, the 10 g magnitudes produced similar outcomes for both the HP and LP stimuli for Nicholas (see the top panel of Figure 10 in Appendix A). Put simply, the HP item did not outperform the LP item when the stimulus magnitudes were 10 g. The 2 g stimulus magnitudes produced slight differential reinforcement effects (see the middle panel of Figure 10). The 0.5 g HP stimulus consistently produced higher breakpoints than the 0.5 g LP stimulus (see the bottom panels of Figure 10 in Appendix A).

For Betty, there were slight differential reinforcement effects with respect to the 10 and 2 g items, but no differential reinforcement effects produced by the 0.5 g magnitudes. As mentioned earlier, consistently low breakpoints impede the ability to draw conclusions regarding differential reinforcer efficacy (see Figure 11 in Appendix A).

The 10 g stimuli produced fairly clear differential reinforcer effects for Tyler (see the top panel of Figure 12 in Appendix A). In contrast to this are the 2 and 0.5 g data that show a lack of differential reinforcer effects (see the middle and bottom panels of Figure 12 in appendix A). As such, 10 g of the HP items resulted in higher breakpoints than the LP items, but the same did not hold true for the 2 and 0.5 g magnitudes.

There may be a methodological flaw inherent in preference and reinforcer assessments when edible items are included in the stimulus arrays. Specifically, this investigation provides preliminary evidence to suggest that various magnitudes of edible items may influence differential reinforcement effects with respect to preference. Therefore, preference assessment validity may be suspect when the stimulus magnitude is not equivalent or controlled. These data suggest that it may not be safe to assume stimulus equality with respect to the items included in preference assessment stimulus arrays, both within stimulus (i.e., different magnitudes) and across stimuli.

Limited conclusions can be drawn regarding whether habituation or satiation was responsible for within session response termination in this investigation. Data for Nicholas suggest that habituation rather than satiation was responsible for the within session decrease in responding. Specifically, Nicholas strung 8 beads, ate the associated 2 g of chocolate chips (i.e., medium magnitude of the HP item) and said he was “all done.” Then, he was presented with 16 beads and told he could string those beads for crackers (i.e., MP item), which he did. Throughout this investigation, the habituation probe was one of two instances in which Nicholas strung 16 beads.

The habituation probe datum for Tyler suggests that satiation was responsible for within session response termination. The 10 g LP item resulted in a breakpoint of 2 as he did not eat the full 10 g edible item associated with the 4 bead requirement. When Tyler was presented with the next bead requirement and told he could have pretzels if he strung those beads (i.e., MP item), he strung the beads but did not consume the entire 10 g portion of pretzels. This pattern of responding suggests that satiation, rather than habituation, was responsible for response termination. While these probes are revealing, they are limited in that only one probe was conducted for two participants, and future research should consider periodic habituation/sensitization probing throughout reinforcement assessment.

The high effort task had insubstantial influence on PR breakpoints. For Nicholas, the medium stimulus magnitudes for both the HP and LP stimuli produced higher breakpoints when a thicker string, which the first author perceived as a more difficult task, was used. For Tyler, the medium stimulus magnitudes resulted in similar breakpoints when the string was thicker. As no test for effort was actually conducted, it stands to reason that either a) the high effort task was not substantially different from the standard task used, or b) the larger thickness made the task easier, and that the standard task was actually more effortful. Thus, future research should consider task effort in their work.

Various notable limitations exist within the current investigation. First, it is unclear whether discrimination with respect to the various magnitudes was achieved. Results similar to those found in Halbur, Linn and Witts (under review) were not reproduced, perhaps due to discriminability issues. Participants were present while the research assistants set up and cleaned up the research materials. Low breakpoints may have been inadvertently reinforced when researchers allowed participants to engage in a perceived HP activity (e.g., watching videos on an electronic hand-held device) while he/she set up and cleaned up. Issues of task difficult also warrant consideration. On the one hand, breakpoints were consistently at or near the maximum possible breakpoint for Tyler, possibly because the task was too easy. On the other hand, breakpoints for Betty were always low, perhaps because bead stringing was more difficult for her. Finally, the stability criteria for PR assessments might have limited our findings. Consider that a +/- 1 tolerance within two subsequent PR breakpoints was used to determine stability. While this tolerance might seem acceptable on the surface, a breakpoint of 8 responses would see subsequent stringing of 4 and 16 beads as “stable.” Because of the large range of responses, the actual responses produced, rather than breakpoint, was used in reporting the data (i.e., in the example above, 8, 4, and 16 were reported, and not breakpoints of 4, 3, and 5).

In light of these findings, reinforcer magnitude should be considered when conducting preference and reinforcer assessments as well as for use as putative reinforcement in skill acquisition. When stimulus magnitude was systematically manipulated, variable breakpoints were produced. Therefore, future research in preference and reinforcer assessment validity should consider stimulus magnitude, especially when edible items are included.

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*Appendix A*

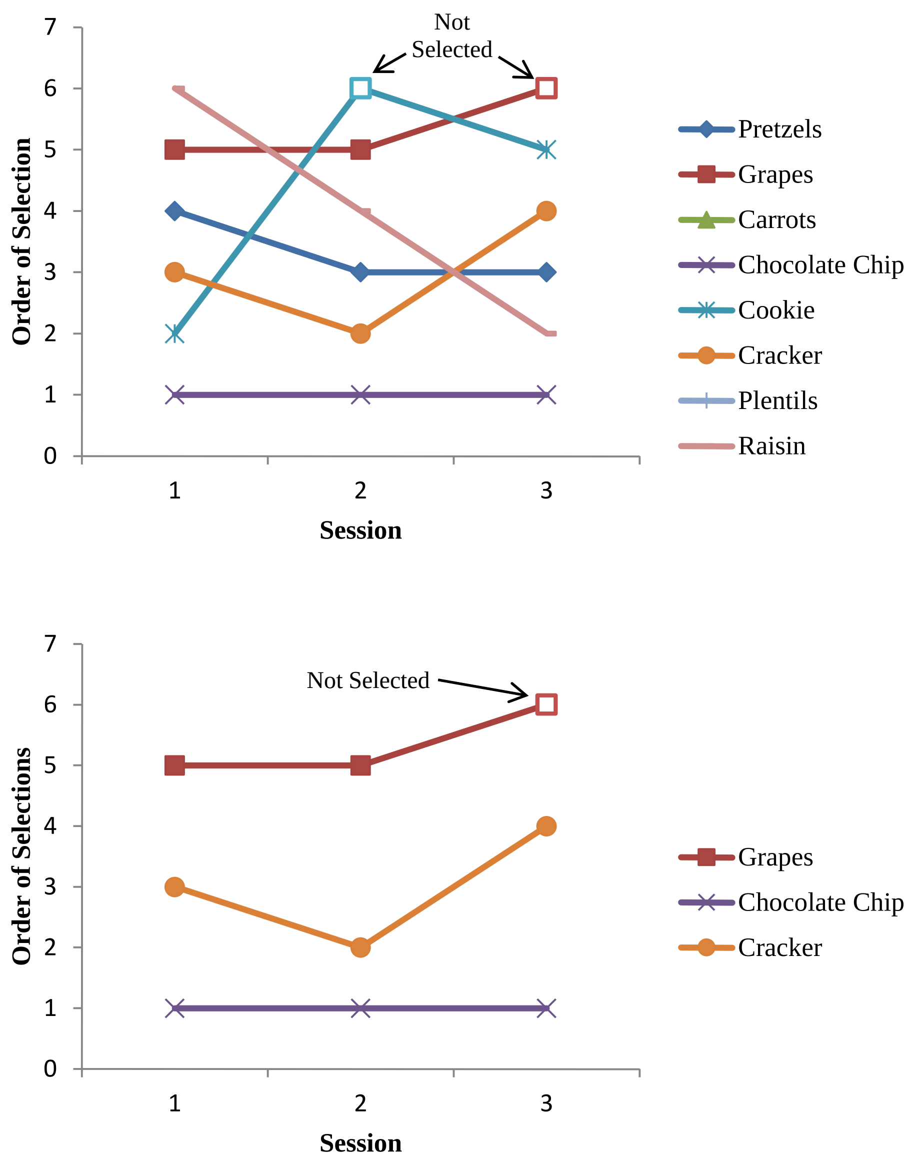


*Figure 1.* The order that Nicholas selected edible items in the primary MSWO preference assessment is illustrated above (top panel). The bottom panel shows the HP, MP, and LP items in isolation.

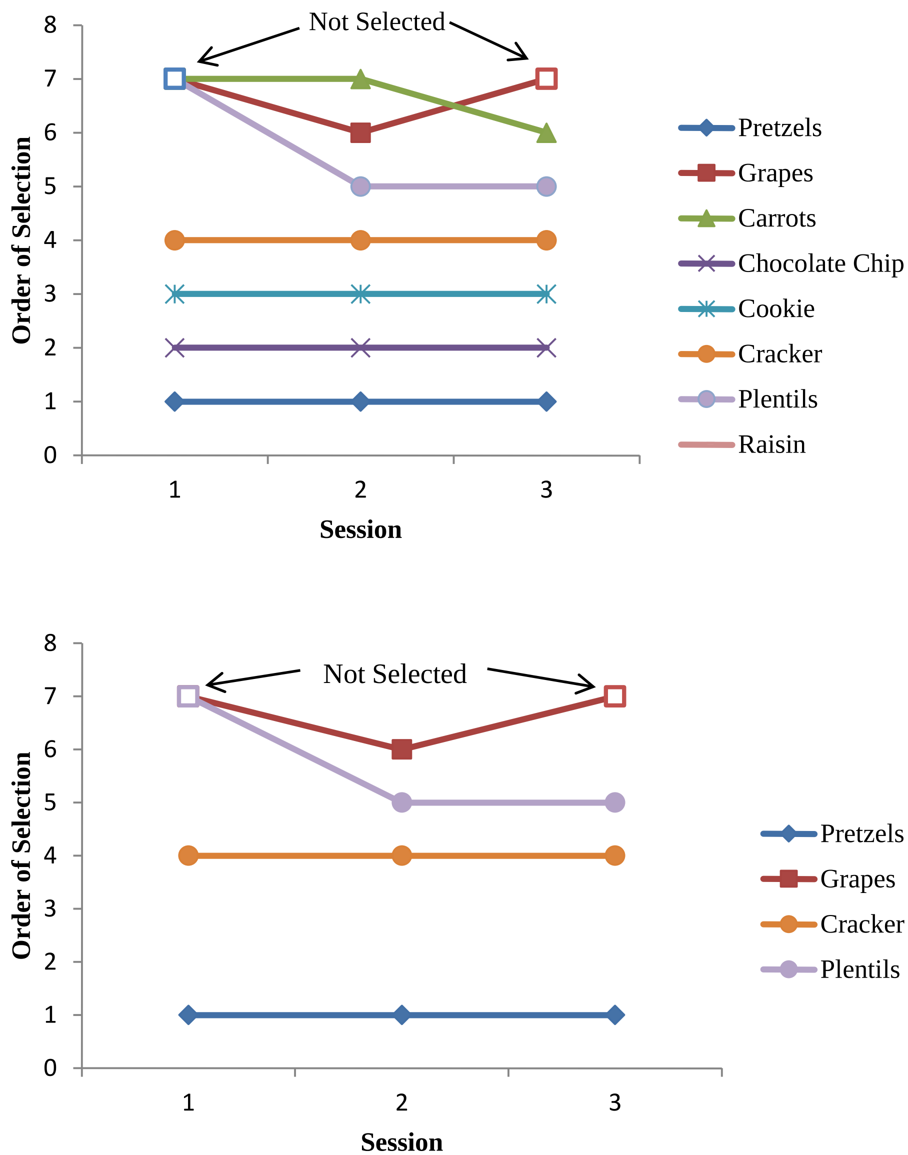


*Figure 2.* The order that Betty selected edible items in the primary MSWO preference assessment is illustrated above (top panel). The bottom panel shows the HP, MP, and LP items in isolation. The LP item was initially grapes and was changed to plentils during the secondary MSWO preference assessment phase due to non-selection of grapes.

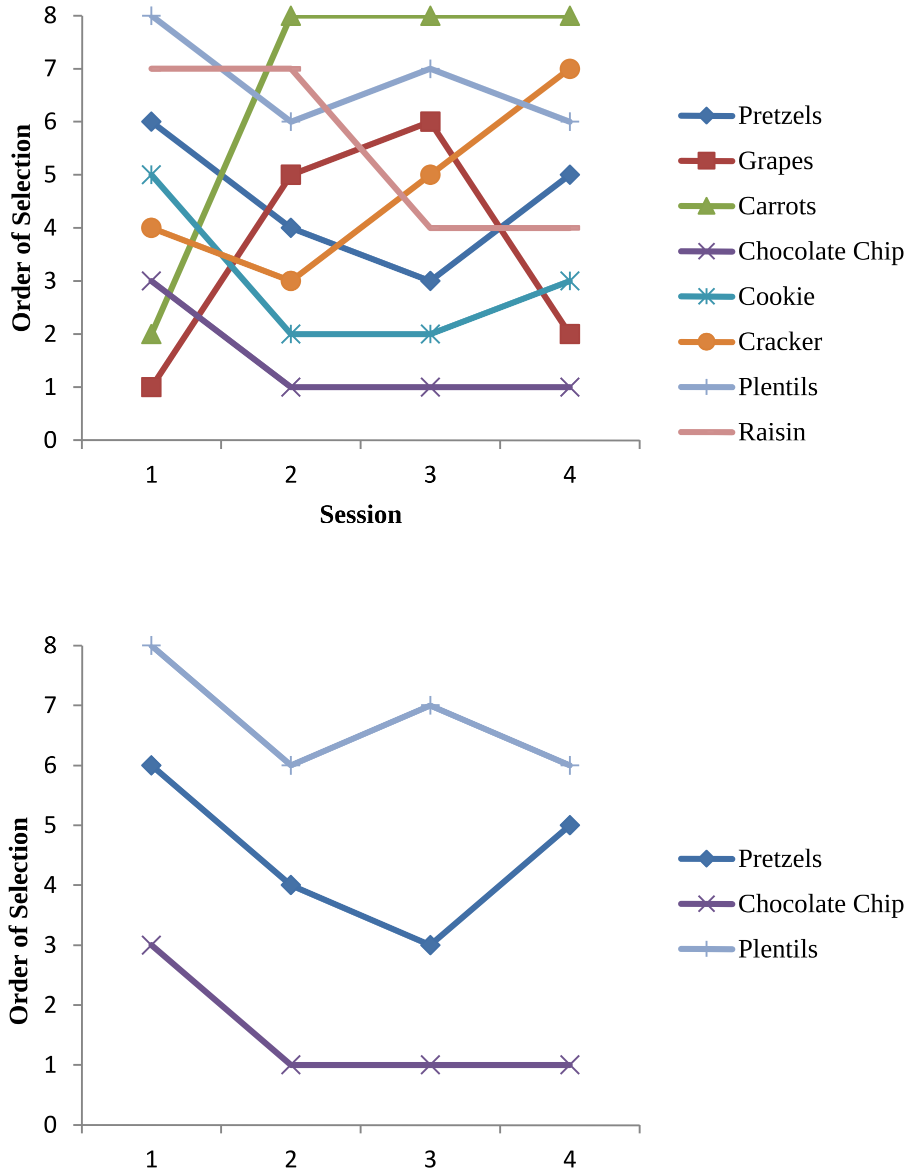


*Figure 3*. The order that Tyler selected edible items in the primary MSWO preference assessment is illustrated above (top panel). The bottom panel shows the HP, MP, and LP items in isolation.

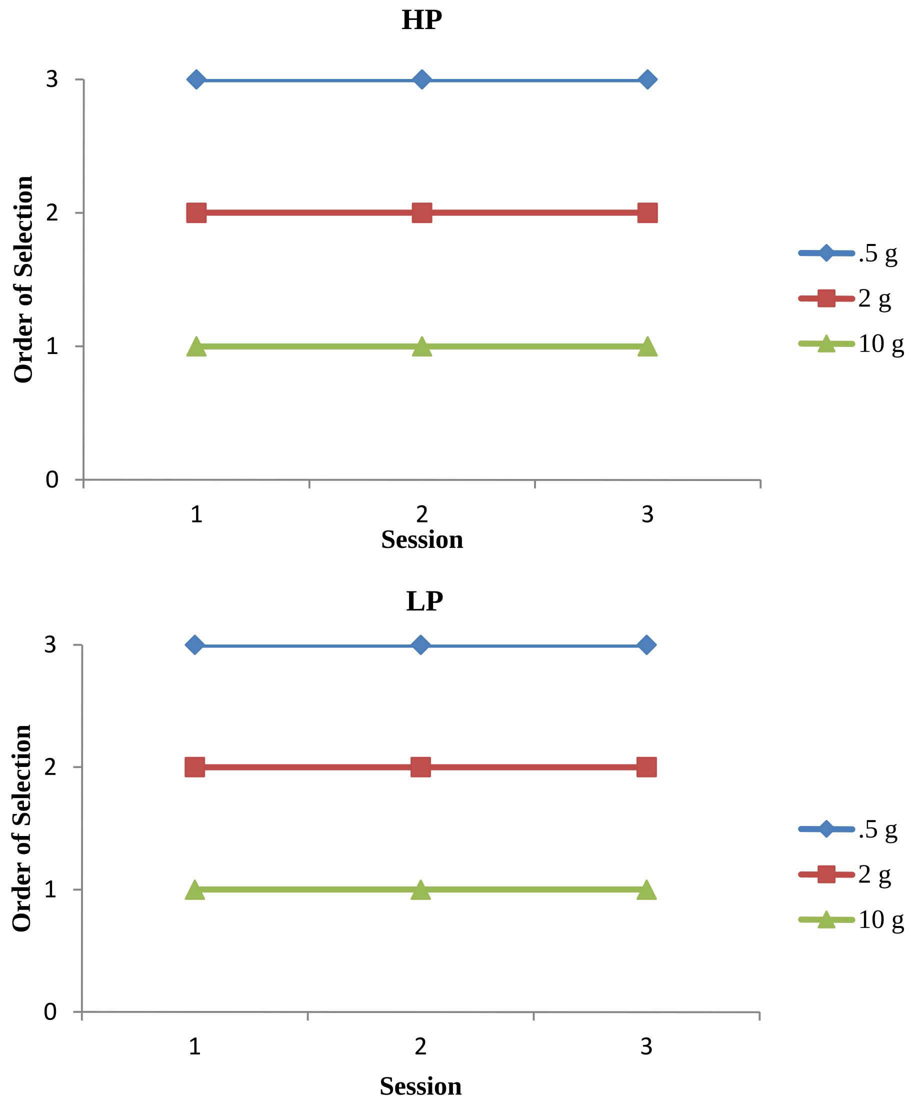


*Figure 4.* The orders that Nicholas selected 0.5, 2, and 10 g of the HP (top panel) and LP (bottom panel) items are pictured above.

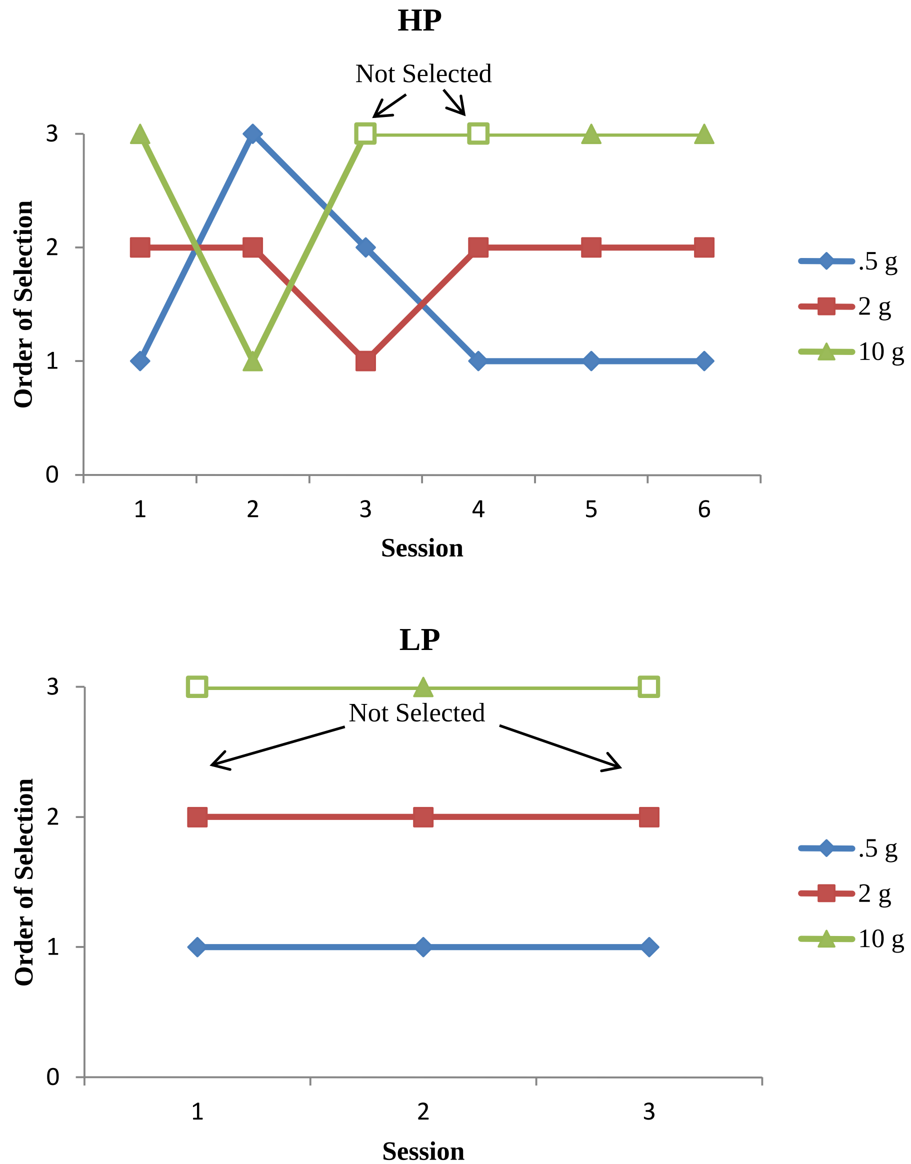


*Figure 5.* The orders that Betty selected 0.5, 2, and 10 g of the HP (top panel) and LP (bottom panel) items are pictured above.

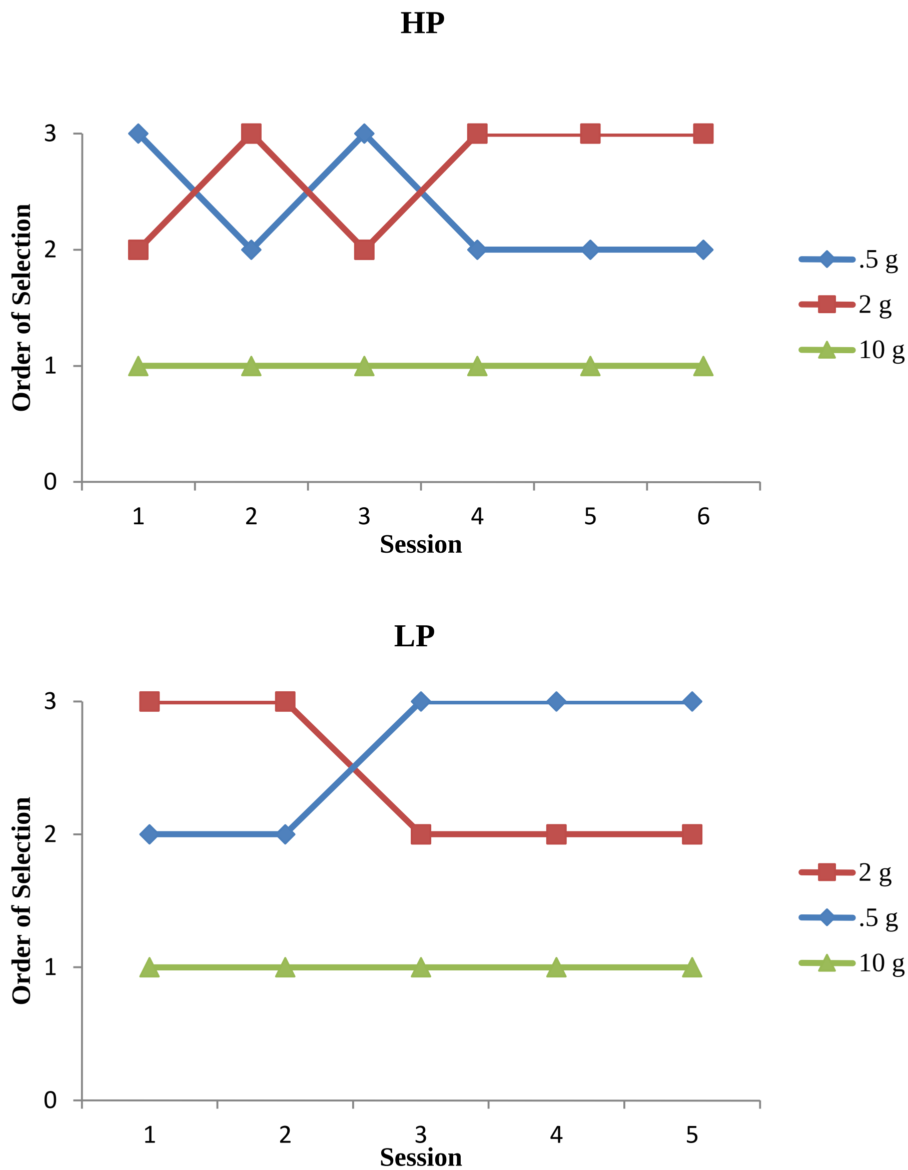


*Figure 6.* The orders that Tyler selected 0.5, 2, and 10 g of the HP (top panel) and LP (bottom panel) items are pictured above.

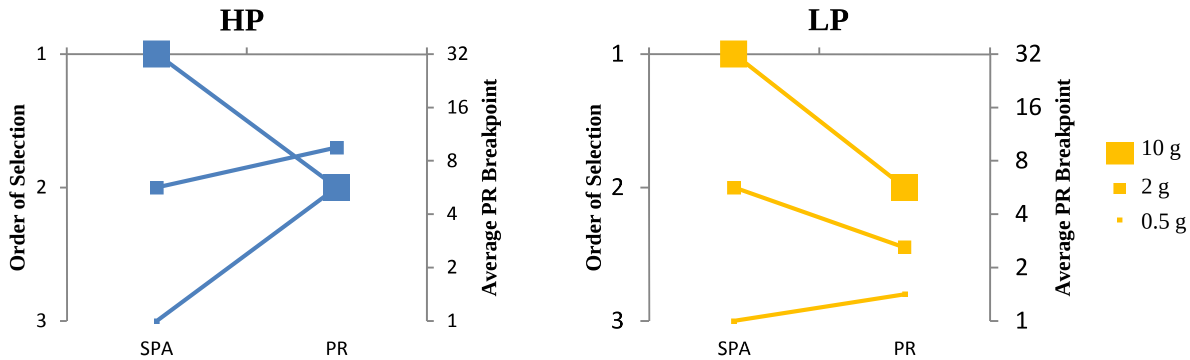


*Figure 7.* The average PR breakpoints for each portion size (i.e., 10, 2, and 0.5 g) of the HP (left) and LP stimuli (right) for Nicholas are illustrated above.

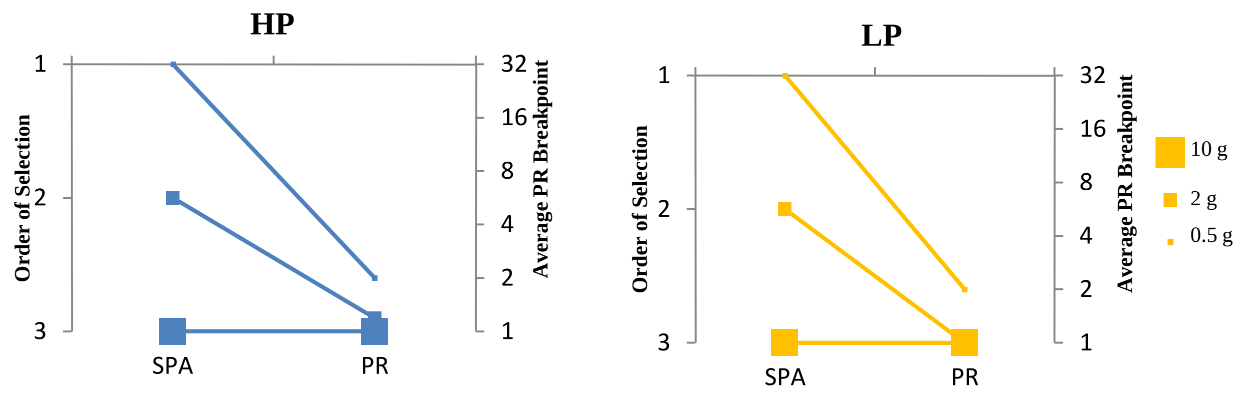


*Figure 8.* Betty’s average PR breakpoints for each portion size (i.e., 10, 2, and 0.5 g) of the HP (left) and LP stimuli (right) are illustrated above.

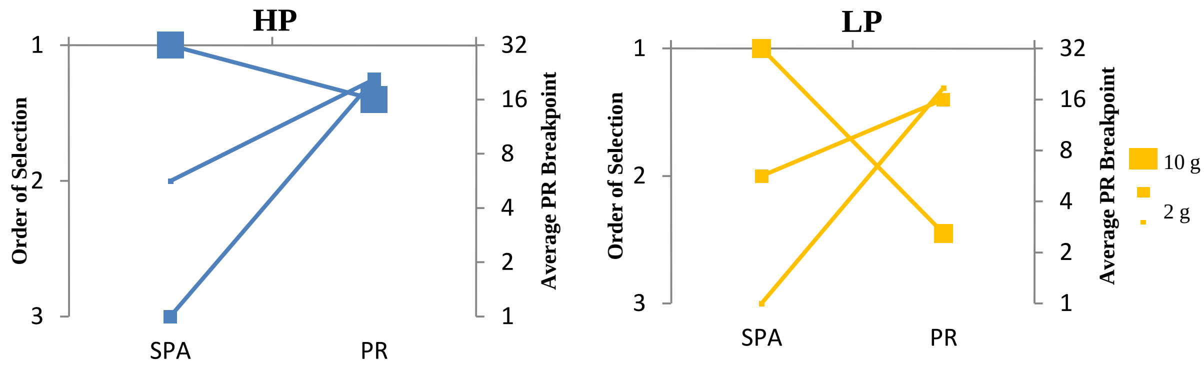


*Figure 9.* Tyler's average PR breakpoints for each portion size (i.e., 10, 2, and 0.5 g) of the HP (left) and LP stimuli (right) are illustrated above.

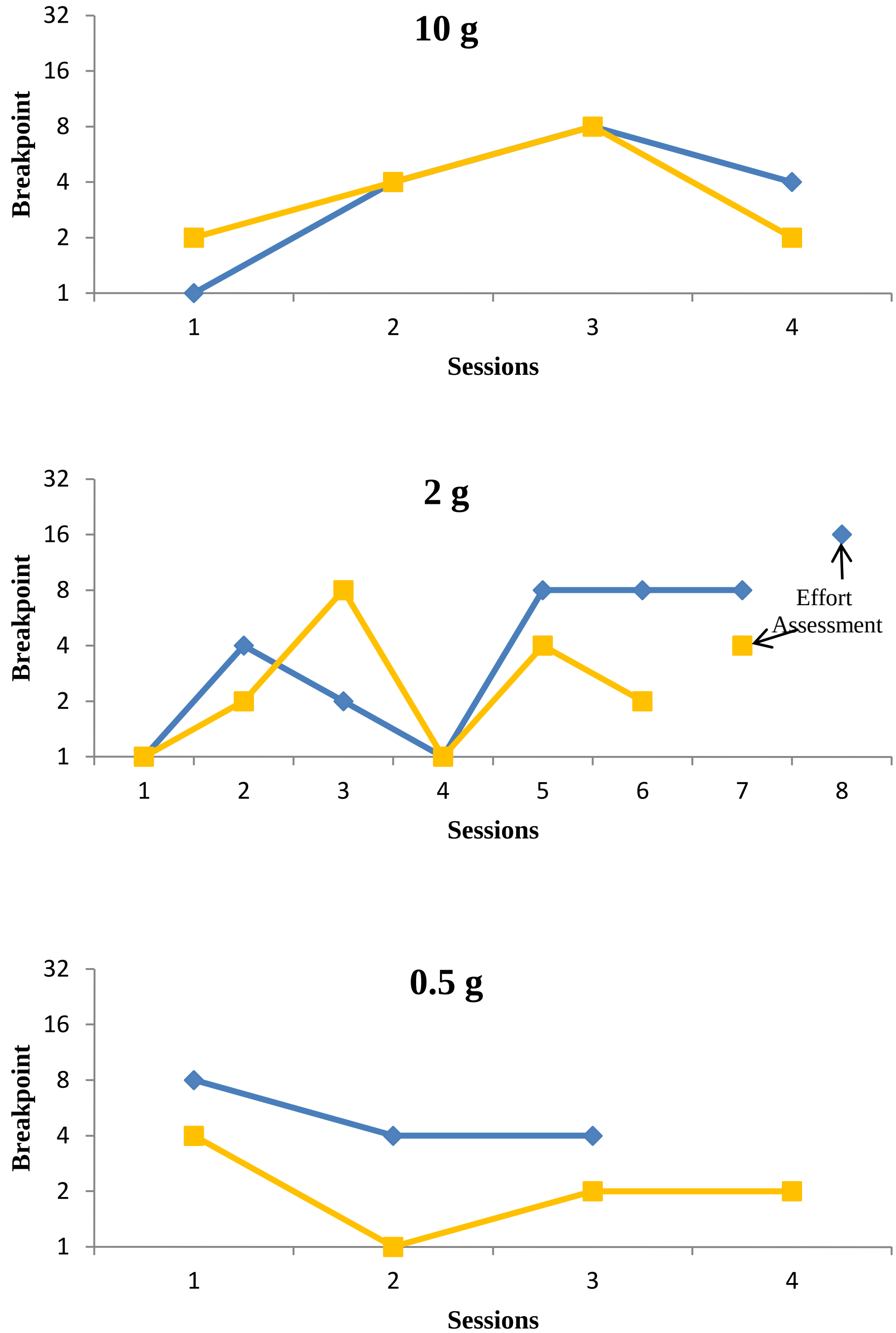


*Figure 10.* The session-by-session breakpoints for the 10 g (top panel), 2 g (middle panel), and 0.5 g (bottom panel) magnitudes for the HP (blue data paths) and LP (yellow data paths) are pictured above for Nicholas.

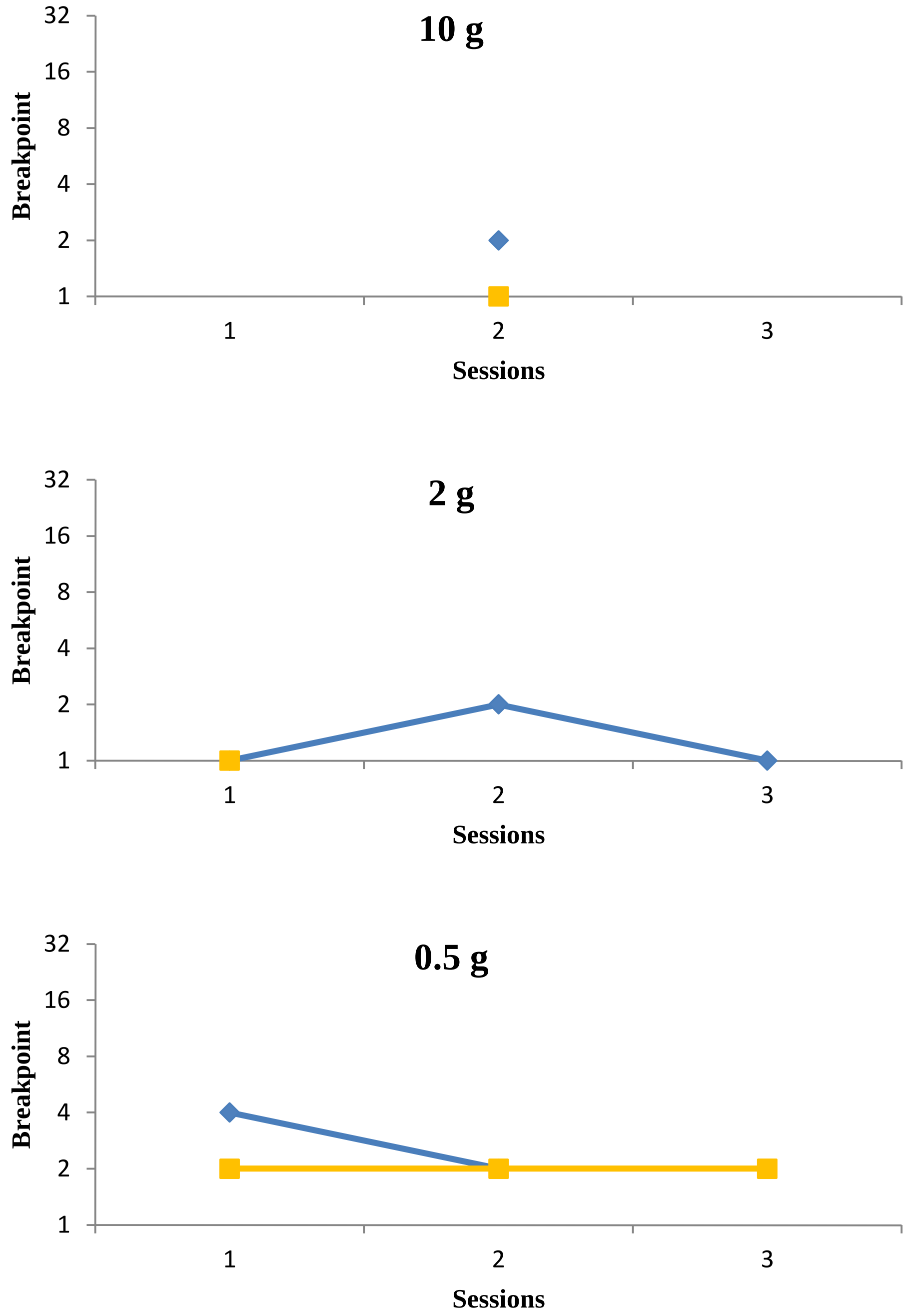


*Figure 11*. Betty's session-by-session breakpoints for the 10 g (top panel), 2 g (middle panel), and 0.5 g (bottom panel) magnitudes for the HP (blue data paths) and LP (yellow data paths) are pictured above.

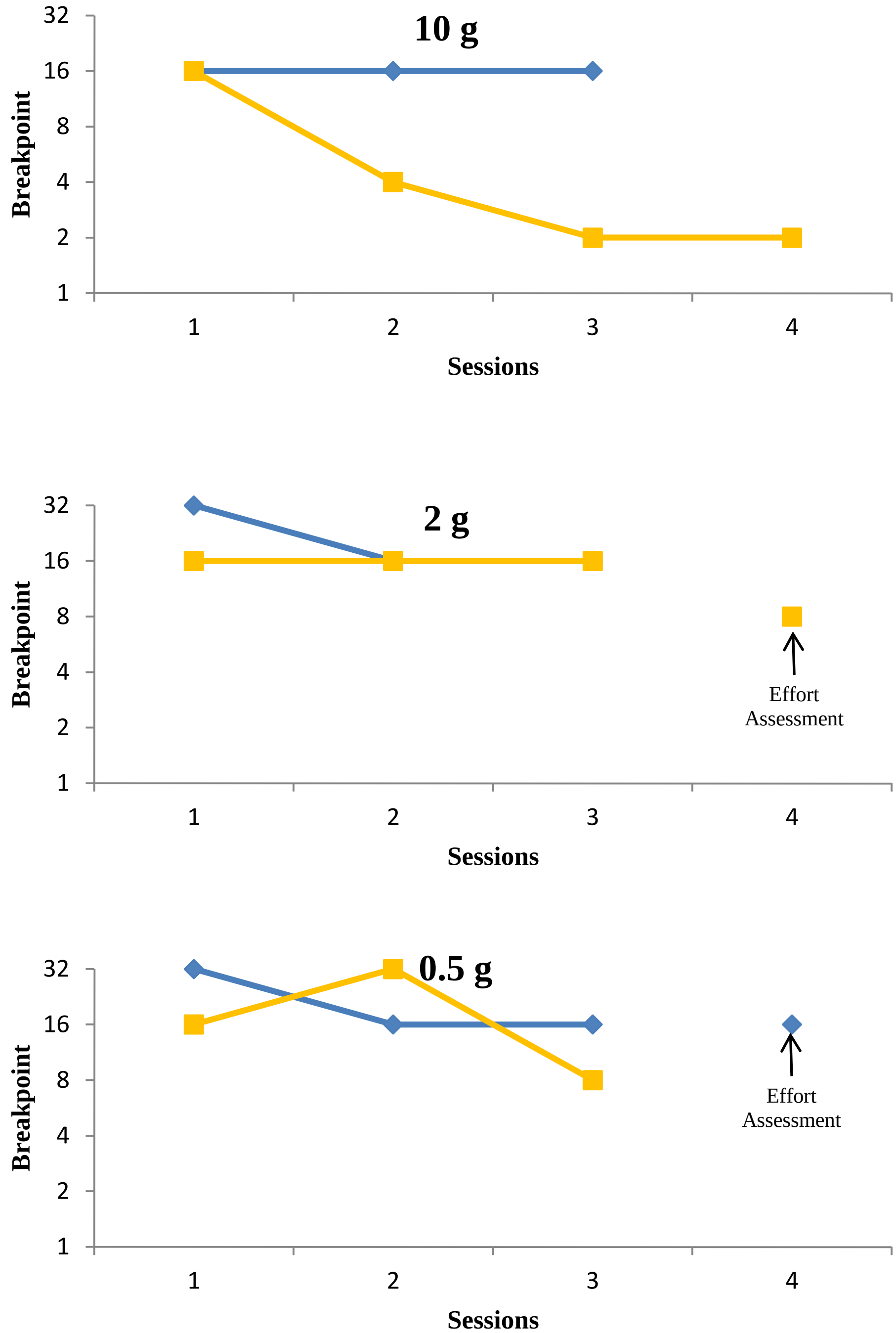


*Figure 12.* Tyler's session-by-session breakpoints for the 10 g (top panel), 2 g (middle panel), and 0.5 g (bottom panel) magnitudes for the HP (blue data paths) and LP (yellow data paths) are pictured above.

Table A

| Condition | Participant | | |
|---|---|---|---|
| | Nicholas | Betty | Tyler |
| Baseline One | 1 | 2 | 3 |
| Baseline Two | 1 | 0 | 0 |
| Baseline Three | 1 | 1 | 1 |
| Average | 1 | 1 | 1.33 |

*Note.* The number of beads Nicholas, two, and three strung during baseline sessions and the overall average number of beads strung across are listed above.

*Appendix B*

| **Training Phase** | **Topics Covered** | **Competency** |
|---|---|---|
| Initial Group Meeting | ☐ Purpose of Study<br>☐ Participants<br>☐ Session Description | ☐ Completed<br>☐ Not Completed |
| Individual Debriefing | ☐ Brief Review of Topics<br>☐ Questions | ☐ Completed<br>☐ Not Completed |
| Role Play | IOA ≥ 90%? ____ | ☐ Pass<br>☐ Fail |

**Script for Individual Debriefing**

[Review all data collection materials, response definitions, and procedural requirements] Do you have any questions on the purpose or procedures? [Answer questions if there are any] Great, first I will model how to run each procedure, then we will role play each procedure. [Model each procedure prior to role playing] We will do a primary preference assessment with eight different food items, secondary preference assessment with different weights of an identical food item, and then a reinforcer assessment. You will be the therapist and I will be the client.

**Script for role play [client] – predetermined assessment outcomes**

***Primary preference assessment.*** [Select the chocolate chips first, pretzels second, red grapes third, chia seed crackers fourth, plentils fifth, cookies sixth, raisins seventh] I don't want that [for the remaining baby carrot].

***Secondary preference assessment.*** [Select the 10 g item first, 2 g item second, and 0.5 g item third].

***Reinforcer assessment.*** [String first, second, and third bags then engage in problem behavior].

*Appendix C*

**Institutional Review Board (IRB)**

OFFICE OF RESEARCH AND SPONSORED PROGRAMS
ST. CLOUD STATE UNIVERSITY.

*Administrative Services 210*
*Website: stcloudstate.edu/osp* *Email: osp@stcloudstate.edu*
*Phone: 320-308-4932*

**Name:** Trista Linn

**Address** 27655 Clear Lake Road
Richmond, MN 56368 USA

**Email:** litr0901@stcloudstate.edu

**IRB PROTOCOL DETERMINATION:**
**Expedited Review-2**

**Project Title:** Consideration of Reinforcer Magnitude with Respect to Preference and Reinforcer Assessment Outcomes

**Advisor** Benjamin Witts

The Institutional Review Board has reviewed your protocol to conduct research involving human subjects. Your project has been: **APPROVED**

Please note the following important information concerning IRB projects:
- The principal investigator assumes the responsibilities for the protection of participants in this project. Any adverse events must be reported to the IRB as soon as possible (ex. research related injuries, harmful outcomes, significant withdrawal of subject population, etc.).

- For expedited or full board review, the principal investigator must submit a Continuing Review/Final Report form in advance of the expiration date indicated on this letter to report conclusion of the research or request an extension.

-Exempt review only requires the submission of a Continuing Review/Final Report form in advance of the expiration date indicated in this letter if an extension of time is needed.

- Approved consent forms display the official IRB stamp which documents approval and expiration dates. If a renewal is requested and approved, new consent forms will be officially stamped and reflect the new approval and expiration dates.

- The principal investigator must seek approval for any changes to the study (ex. research design, consent process, survey/interview instruments, funding source, etc.). The IRB reserves the right to review the research at any time.

Good luck on your research. If we can be of further assistance, please contact the Office of Research and Sponsored Programs at 320-308-4932 or email lidonnay@stcloudstate.edu. Use the SCSU IRB number listed on any forms submitted which relate to this project, or on any correspondence with the IRB.

**Institutional Review Board:**

Linda Donnay

Linda Donnay
IRB Administrator
Office of Research and Sponsored Programs

**St. Cloud State University:**

M Hart

Marilyn Hart
Interim Associate Provost for Research
Dean of Graduate Studies