SENSITIVITY OF HUMAN CHOICE TO MANIPULATIONS OF PARAMETERS OF POSITIVE AND NEGATIVE SOUND REINFORCEMENT

by

Joseph M. Lambert

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Approved:

Sarah E. Bloom Major Professor	Andrew L. Samaha Committee Member
Timothy A. Slocum Committee Member	Thomas S. Higbee Committee Member
Michael P. Twohig Committee Member	Mark R. McLellan Vice President for Research and Dean of the School of Graduate Studies

UTAH STATE UNIVERSITY
Logan, Utah

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ABSTRACT

Sensitivity of Human Choice to Manipulations of Parameters

of Positive and Negative Sound Reinforcement

by

Joseph M. Lambert, Doctor of Philosophy

Utah State University, 2013

Major Professor: Dr. Sarah E. Bloom
Department: Special Education and Rehabilitation

Evidence of the utility of parameter sensitivity assessments in the assessment and treatment of problem behavior is beginning to emerge. Although these assessments have been conducted to evaluate participant sensitivity to parameter manipulations in both positive and negative reinforcement paradigms, no convincing evidence currently exists demonstrating that separate assessments of positive and negative reinforcement are required. The purpose of the current investigation was to determine whether positive and negative reinforcement processes have differential effects on human response allocation when parameters of responding and reinforcement are manipulated. Three undergraduate students participated in a series of assessments designed to identify preferred and aversive sounds with similar reinforcing values. Following sound identification, therapists conducted parameter sensitivity assessments for both positive and negative reinforcers. Parameter manipulations influenced behavior in the same way across reinforcement processes for two participants. However, for one participant, the way in which parameter manipulations influenced behavior differed according to the reinforcement process. Thus, for at least some individuals, positive and negative reinforcement processes do not always influence behavior in identical ways. Clinical and theoretical implications are discussed.

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The purpose of this study was to determine whether altering parameters of positive and negative reinforcement in identical ways could influence behavior maintained by each in different ways. Three undergraduate students participated in a series of assessments designed to identify preferred and aversive sounds with similar reinforcing values. Following reinforcer identification, we conducted parameter sensitivity assessments for both positive and negative reinforcers. Parameter manipulations influenced behavior in the same way across reinforcement processes for two participants. However, for one participant, the way in which parameter manipulations influenced behavior differed according to the reinforcement process. Our results suggest that, for at least some individuals, positive and negative sound reinforcement processes do not influence behavior in identical ways. Clinical and theoretical implications are discussed.

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INTRODUCTION

The Matching Law

The matching law (Baum, 1974; Herrnstein, 1961, 1970) is a model of behavior that conceptualizes every response emitted by an organism as a selection of one, among an array, of concurrently available contingencies of reinforcement (i.e., a "choice"). The law predicts that the proportion of responding that an organism allocates toward a contingency will be equal to the proportion of reinforcement provided by said contingency (in relation to the total amount of reinforcement available in the target context).

Research on the matching law typically employs a concurrent schedules arrangement (Catania, 1963) in which two different variable interval (VI) schedules of reinforcement are simultaneously made available to a participant. Given the assumptions of the matching law, predicting the proportion of an individual's response allocation in a choice paradigm should be relatively straightforward (e.g., a participant should allocate roughly 80% of his or her responding toward a VI 30 s schedule of reinforcement if the alternative is a VI 120 s schedule of reinforcement and a single cookie is provided contingent upon schedule completion at either alternative). However, research has shown that there are a number of variables that can complicate prediction of human response allocation. For example, Mace, Neef, Shade, and Mauro (1994) verified that human behavior can not only be generally characterized by undermatching (i.e., allocating fewer responses toward an option than the amount required to maximize reinforcement at that option) and bias, but also showed evidence that the behavior of some humans becomes increasingly less sensitive to schedule changes (i.e., less likely to change in conjunction with contingency changes) that occur in purportedly familiar environments. Despite this propensity toward insensitivity in familiar environments, Mace et al. showed that adjunct procedures (i.e., change-over delays, limited holds, visual displays, and modeling) could be employed to increase the probability that response allocation conform to predictions of the matching law.

These procedures are important because when an individual's behavior demonstrates sensitivity to differences in the availability of reinforcement at two different options (i.e., responding conforms to the matching law) then his/her response allocation in choice paradigms becomes a useful measure of the relative reinforcing value of the consequences provided at each option. Research informed by the matching law has uncovered a number of subtle and intricate reinforcement variables that influence human behavior.

Parameters of Reinforcement

Because choices between alternatives that don't differ along at least one parameter of responding (e.g., effort) or reinforcement (e.g., rate, quality, magnitude, or delay) are relatively rare, one class of variables that can complicate the prediction of a human's response allocation in a choice paradigm is an individual's differential sensitivity to said parameters. In fact, responding that deviates from programmed contingencies (e.g., is over, or under, allocated toward specific response options and, thus, impedes the maximization of reinforcement) can often be explained by identifying differences in the dimensions of different parameters of responding or reinforcement when two different contingencies provide seemingly identical reinforcers. For example, Horner and Day (1991) conducted a functional analysis (FA; Iwata, Dorsey, Slifer, Bauman, & Richman, 1994) of the problem behavior of three participants and then implemented functional communication training (FCT; Carr & Durand, 1985) to decrease said behavior. However, during FCT, they intentionally taught one participant an effortful alternative response, imposed a 20 s delay to reinforcement following the emission of an alternative response for another participant, and reinforced the alternative response on a leaner (fixed-ratio [FR] 3) schedule than the schedule for problem behavior (FR1) for the final participant. They did this to demonstrate that providing seemingly identical consequences for purportedly functionally equivalent responses will not always decrease problem behavior if variations in important parameters of responding and/or reinforcement are not controlled. After each intervention was shown to be ineffective, Horner and Day taught participants more efficient alternative responses and problem behavior was subsequently decreased.

As was the case for participants in Horner and Day (1991), individuals are frequently given choices among alternatives that vary across at least one response or reinforcement parameter. This variability apparently makes experience with, otherwise identical, reinforcers qualitatively different because responding can be altered when dimensions of reinforcement are altered.

Identifying Individuals' Sensitivities to Different Parameters

In an experiment meant to identify how parameters of reinforcement can interact with each other to influence choice, Neef, Mace, Shea, and Shade (1992) first showed that the behavior of three participants would conform to the matching law in a concurrent arrangement of unequal VI 30 s VI 120 s schedules when all other parameters of responding and reinforcement were kept constant. Then, keeping the same schedules of reinforcement, Neef et al. altered the quality of reinforcement provided at each schedule so that money (a high quality reinforcer) was provided contingent upon responding in the leaner schedule and tokens exchangeable for goods at a school store (a low quality reinforcer) were provided contingent upon responding in the richer schedule. The results of this experiment showed that the higher quality reinforcer pulled a larger percentage of response allocation toward the leaner schedule than the 20% that would be expected if rate of reinforcement had been the only parameter of reinforcement considered.

Likewise, Neef, Mace, and Shade (1993) arranged an experiment in which reinforcement rates were two to four times greater for the richer response alternative than for the leaner. However, they arranged for reinforcer delivery to be delayed by up to two weeks in the richer schedule. This delay decreased the proportion of responding allocated toward the richer schedule than what would have been predicted if only rates of reinforcement were considered.

Conversely, Mace, Neef, Shade, and Mauro (1996) altered response difficulty so that responding in leaner schedules was easier (simple math problems) to complete than responding in richer schedules (difficult math problems) and found that this manipulation did not alter response allocation patterns in a meaningful way. However, response patterns were modified when reinforcer quality was altered across schedules. This was true even when higher quality reinforcers competed directly with lower response effort and richer schedules of reinforcement combined.

As was shown by Neef et al. (1992) and Neef et al. (1993) parameters of reinforcement can interact with each other to alter human response allocation in ways that neither parameter, alone, could do in isolation. How, specifically, these interactions influence behavior is difficult to predict because people are more sensitive to some parameters than others (e.g., Mace et al., 1996) and these sensitivities are relatively idiosyncratic to each individual. For example, in a second experiment conducted by Neef et al. (1993) the authors pitted reinforcer rate against reinforcer quality and immediacy and found that, for one participant, the combination of quality and rate influenced behavior more than immediacy. However, for the other participant immediacy was more influential than the combination of rate and quality.

Likewise, Neef, Shade, and Miller (1994) found that the dimension that was most influential to response allocation differed across participants. They also found that changing the properties of one reinforcer dimension could alter the value of other dimensions. Neef and Lutz (2001a) replicated the findings of Neef et al. (1994) with more participants (11) using a briefer computer based assessment protocol in which each reinforcement parameter was pitted against every other parameter just once and only select replications were made (e.g., those that pitted the most and least influential dimensions against each other) to establish experimental control.

The results of these studies showed that the effect of a reinforcer is always context dependent and that an analysis of contingency that only goes as far as type, or rate, of reinforcement can be inadequate. Additionally, this research verified that choice making is an orderly process that is informed by specific dimensions of parameters of responding and of reinforcement in relation to those of other concurrently available alternatives. Fortunately, with this orderliness comes a degree of predictive utility and Neef et al. (1994) and Neef and Lutz (2001a) outlined a useful assessment methodology for identifying an individual's general sensitivity to manipulations of each parameter.

Applying Knowledge of Parameter Sensitivity to Interventions

Empirical evidence is growing demonstrating that parameter sensitivity assessments have a number of useful applications in applied settings. Thus far, research has demonstrated that parameter sensitivity assessments can be useful for empirically demonstrating general behavioral tendencies of individuals diagnosed with specific disabilities (i.e., the impulsivity of children diagnosed with attention-deficit hyperactivity disorder) and for evaluating the behavioral effect of medication commonly prescribed to address these tendencies. Additionally, parameter sensitivity assessments have highlighted important variables that have proven useful in informing effective treatments of impulsive behavior, and of problem behavior in general.

For instance, Neef and Lutz (2001b) used the modified assessment procedure outlined by Neef and Lutz (2001a) to evaluate the sensitivity to parameter changes of children who engaged in problem behavior. Following this evaluation, Neef and Lutz (2001b) applied the results of the assessment to the treatment of said problem behavior. In their experiment they manipulated the most influential parameter (immediacy for one participant and quality for the other) and found that behavior interventions (differential reinforcement of low-rates [DRL] for both participants) were effective when said manipulations were favorable (i.e., immediate or high quality) and were not effective when said manipulations were unfavorable (i.e., delayed or moderate quality).

Neef, Bicard, and Endo (2001), Neef, Bicard, Endo, Coury, and Aman (2005), and Neef, Marckel, et al. (2005) also used the assessment procedure outlined by Neef and Lutz (2001a) to identify the most influential parameters of reinforcement for children diagnosed with attention-deficit hyperactivity disorder (ADHD). For participants diagnosed with ADHD across these three studies, all were generally most influenced by the immediacy of reinforcer delivery; demonstrating impulsivity (defined by the authors as choosing smaller sooner reinforcers instead of larger later ones). By contrast, the most influential parameter of reinforcement for a control group containing children not diagnosed with ADHD in Neef, Marckel, et al. (2005) was reinforcer quality. Furthermore, both Neef, Bicard, Endo, Coury, & Aman (2005) and Neef, Marckel, et al. (2005) showed that medication commonly prescribed to individuals diagnosed with ADHD (amphetamine salts, methylphenidate, d-amphetamine, or dextroamphetamine) did not alter the influence of immediacy (impulsivity) on choice allocation for the participants evaluated in their experiments.

Conversely, a behavioral intervention outlined by Neef, Bicard, & Endo (2001), that was informed by the results of parameter sensitivity assessments, did decrease the influence that reinforcer immediacy had on the choices of its participants. In their preparation, Neef et al. used the results of the parameter assessment to inform a “self-control” training procedure they had designed for children with ADHD who had demonstrated impulsivity. In said training the authors identified values for which the second most influential parameter (quality for two participants and rate for one) directly competed with immediacy. Using a fading procedure, the authors gradually increased the delay to the higher quality (or rate) of reinforcement until responding favored the higher quality (or rate) of reinforcement at the terminal delay for each participant. Interestingly, during a subsequent choice assessment, the “self-control” training generalized to untrained dimensions of responding and/or reinforcement so that the participants chose higher quality and rates of reinforcement over lower quality or rates of reinforcement that were more immediately available, or less effortful to obtain.

In another study designed to decrease the impulsive choices of its participants, Perrin and Neef (2012) showed that manipulating different parameters of aversive stimuli (i.e., delay to task, difficulty of task, and magnitude of task) across two choices could decrease impulsivity (defined in this instance as choosing the more immediate but smaller or less difficult task over the delayed and larger or more difficult one) and increase self-control in a negative reinforcement paradigm. Furthermore, the authors demonstrated that providing participants with an opportunity to commit to a “self-control” response chain prior to requiring them to engage in the work required by said chain, increased self-control across participants. Thus, the authors identified two separate ways to train self-control responses for negatively reinforced behavior. First by pitting preferred dimensions of reinforcement in direct competition with each other and implementing a fading procedure and, second, by providing participants with an opportunity to commit to the more favorable option prior to requiring them to work for said option.

Positive and Negative Reinforcement

With the exception of one study (i.e., Perrin & Neef, 2012), all research demonstrating the utility of the parameter sensitivity assessment in applied settings has dealt exclusively with positive reinforcement. In the one study that evaluated negative reinforcement (i.e., Perrin & Neff, 2012), the contingencies were arranged in such a way that responding produced avoidance of anticipated events, not escape from current events. Thus, little is known about how changes in parameters of negative reinforcement affect behavior in general and nothing is known about how changes in parameters of escape, specifically, affect behavior.

Although different assessments for positively and negatively reinforced behavior could be justified, some leaders in the field of applied behavior analysis might argue that separate assessments are not useful and, potentially, impossible. For example, Michael (1975) argued that the distinction between positive and negative reinforcement is arbitrary and adds nothing to a description of the reinforcement process. Specifically, Michael pointed out that the positive/negative distinction is limited because only *changes* in the environment can function as consequences of behavior. Because a change contingent upon behavior constitutes the removal of a pre-behavior condition (e.g., a series of teacher demands) and the presentation of a post-behavior condition (e.g., a demand-less period) in a purportedly symmetrical fashion, it is not useful to emphasize the presentation of one condition while omitting a discussion of the concurrent removal of another condition (or vice versa). Mixon (1975) took a similar stance and, 30 years later, Baron and Galizio (2005) did as well.

The crux of Michael's argument hinges largely upon how we choose to define reinforcement. For example, if we agree that the most logical definition of positive reinforcement is the contingent presentation of a *condition* or *context* that increases the future probability of behavior, then distinguishing positive from negative reinforcement is impossible (because the presentation of a stimulus presents a context of increased stimulation and removes a context of no, or less, stimulation). However, if we decide that it is the contingent presentation of a *stimulus* (specifically) that increases the future probability of behavior then distinguishing positive from negative reinforcement becomes possible (most contemporary textbooks of applied behavior analysis define reinforcement in these latter terms).

However, regardless of how we choose to define reinforcement and/or punishment, if there is no functional difference in the effect that the positive/negative processes have on behavior then it may not matter whether or not they are technically distinguishable. If it is possible to learn everything about environmental control through detailed analyses of positive reinforcement contingencies then experiments designed to evaluate the effects of negative reinforcement are not useful and, potentially, not ethical. Conversely, if these two processes affect behavior in different ways then separate analyses of these processes would not only be justified, they would be necessary.

For instance, if we could show that positive and negative reinforcement can influence behavior in different ways, then we might need to determine whether those differences are relevant to skill acquisition and discrimination learning. Additionally, the effect of medications, like the ones evaluated by Neef and colleagues, may need to be established in both positive and negative reinforcement parameter sensitivity assessments before conclusions about the effect of such medications could be made. Finally, we may need to evaluate whether the results of positive reinforcement parameter sensitivity assessments are valid informants of interventions of negatively reinforced problem behavior.

For example, if a child's escape-maintained problem behavior is severe and extinction is not an option, the current literature suggests that it might be useful to identify the child's sensitivity to different reinforcement parameters using the parameter sensitivity assessment outlined by Neef and Lutz (2001a) and then to design an intervention in which preferable dimensions of targeted parameters of reinforcement are provided for appropriate behavior and un-preferable dimensions are provided for problem behavior. However, if the child is most sensitive to the magnitude parameter of positive reinforcement but is most sensitive to the immediacy parameter of negative reinforcement, then the therapist will manipulate the wrong parameter (i.e., magnitude) during his/her intervention for the escape-maintained problem behavior and the treatment may not be effective.

Unfortunately, no research on positive and negative reinforcement has produced convincing evidence either that the distinction is, or is not, functionally justified (Lattal & Lattal, 2006; Marr, 2006). In order for research on differences/similarities of the positive and negative distinction to produce uncontroversial results, the stimulus manipulations used in these experiments would need to be thoughtfully selected. For example, positive and negative processes should not be identified via secondarily defined terms (e.g., the presentation of the absence of attention) (Iwata, 2006). Additionally, clear examples of each process should be evaluated in these experiments. For example, because ingestion of an aspirin (positive) purportedly produces the removal (negative) of internal pain, aspirin ingestion should not be used in an experiment meant to parse the effects of positive from negative reinforcement. Finally, the stimulus manipulated in the analysis of positive reinforcement should belong to the same stimulus class as the stimulus manipulated in the analysis of negative reinforcement (Lattal & Lattal, 2006).

In accordance with these guidelines I presented preferred sounds contingent upon behavior during evaluations of participant sensitivity to positive reinforcement parameter changes. Likewise, I removed aversive sounds contingent upon behavior during evaluations of participant sensitivity to negative reinforcement parameter changes. Furthermore, I equated the reinforcing value of preferred sound presentation and aversive sound removal prior to evaluating the effect of parameter manipulations on behavior.

Preference and Reinforcer Assessments

Reinforcers can be difficult to identify because the term “reinforcer” does not describe a specific object. The term “reinforcement” describes a relationship between three environmental events: an antecedent event that evokes a response, the response itself, and the consequent event that increases the future probability of that response occurring again in the presence of the antecedent event. Thus, “reinforcement” describes an interaction between environmental events and behavior. Objects/events may or may not serve as a “reinforcer” at any given time because reinforcement is an event that is defined by its effect on behavior. Because an item or event can function as a reinforcer under some conditions and not others, it is important to verify whether the programmed consequence of a given experiment or intervention functions as a reinforcer prior to initiating said experiment or intervention. For this specific reason a technology for identifying an individual's relative preference for different stimuli has been developed.

Preference Assessments

In general, two different classes of preference assessment exist. The first class consists of indirect preference assessments such as checklists, questionnaires, and/or caregiver reports. The second class consists of direct preference assessments such as observation and/or experimental manipulation. Previous research has shown that there is not a high correspondence between the preference hierarchies established by indirect assessment and those established by direct assessment (cf., Fisher, Piazza, Bowman, & Amari, 1996; Green, Reid, Canipe, & Gardner, 1991; Parsons & Reid, 1990; Windsor, Piche, & Locke, 1994). However, despite the decreased validity inherent in indirect assessments, such assessments can be useful in identifying the stimuli to be evaluated in direct preference assessments (Hagopian, Long, & Rush, 2004). Although direct assessments are generally more valid than indirect assessments (i.e., they measure preference by evaluating how assessed items/events influence choice), there are a wide variety of direct assessment procedures that have been used to determine a participant's preference for different stimuli. I will discuss the strengths and limitations of those most widely used.

Pace, Ivancic, Edwards, Iwata, and Page (1985) noted that for many developmentally disabled individuals it is challenging to identify high-preferred stimuli by simply asking them, or their care-providers, what they like. Thus, they designed a systematic preference assessment for identifying high-preferred stimuli for such populations. In their study, Pace et al. exposed six individuals with profound intellectual disabilities (ID) to eight preference assessment sessions. Each session consisted of 20 trials in which four different stimuli were presented individually, five times each, in a counterbalanced order. During a trial each child was given 5 s to approach the presented stimulus. Therapists reinforced approaches with 5 s of access to the target stimulus. After each of 16 different stimuli had been presented 10 times to each child, preference hierarchies were established by comparing the percentage of approaches that a child made toward each stimulus. Pace et al. determined that high-preferred stimuli were those for which children approached more than 80% of the time and low-preferred stimuli where those for which children approached less than 50% of the time. Pace et al. noted that their assessment was useful for determining general preference for different stimuli but acknowledged that it did not directly determine whether any of the stimuli they evaluated were actual reinforcers. Thus, in a second experiment they made access to high- and low-preferred stimuli contingent upon task compliance. As was expected, high-preferred stimuli generally produced more task completions than low-preferred stimuli; however, this was not true for all participants. Thus, although the procedure outlined by Pace et al. demonstrated some predictive value of reinforcer efficacy, it is better conceptualized as a preference assessment than it is as a reinforcer assessment. That is to say, it may not be an accurate assessment of the reinforcing efficacy of evaluated stimuli.

One limitation of the Pace et al. (1985) procedure noted by Fisher et al. (1992) was that individuals could, and often would, approach many of the stimuli evaluated every single time they were presented. Thus, although the Pace et al. procedure identified whether or not individuals preferred to engage with any specific stimulus, it was not particularly effective at differentiating an individual's relative preference among a group of preferred stimuli. In order to control for this, Fisher et al. designed a paired-stimulus preference assessment (PSPA) procedure using a concurrent operant paradigm in which two stimuli were simultaneously presented at the beginning of each trial. However, individuals were not given access to both stimuli. Instead, they were only allowed access to the first stimulus they approached (attempts to approach both stimuli were blocked). Each stimulus was paired once with every other stimulus. In this way, individuals were forced to choose between stimuli and provide a direct measure of their preference for a stimulus relative to the other stimuli evaluated. Fisher et al. then pitted stimuli identified to be highly preferred via the Pace procedure (and not highly preferred via the Fisher procedure) against stimuli identified to be highly preferred via the Fisher procedure (and not via the Pace procedure) in a forced choice reinforcer assessment. In this assessment access to each stimulus was provided contingent upon completion of an arbitrary task specific to that stimulus. In all cases evaluated, the high-preferred stimuli identified via the Fisher procedure were selected more frequently than the high-preferred stimuli identified via the Pace procedure; indicating that the Fisher procedure is a more accurate assessment of an individual's preference for stimuli among an array of options.

Although the PSPA is a valid measure of relative preference, its most notable limitation is that it requires a lot of time to conduct. Other researchers have designed derivations of the PSPA with the aim of maintaining its validity while decreasing assessment time. One derivation of the PSPA is a group presentation, or multiple stimulus (MSW), preference assessment in which all stimuli being evaluated are presented to the individual simultaneously. Because the individual is only allowed to select one item to engage with during any given trial, the choice component of the PSPA is preserved in this procedure. However, because all stimuli evaluated are concurrently available the procedure requires considerably fewer trials than the PSPA. Windsor et al. (1994) conducted a study to compare the rank order of preference for six stimuli using the results of staff report, a PSPA, and an MSW assessment. They also evaluated the consistency of the rank ordering across the PSPA and the MSW assessments and the average duration of each. They found that rank ordering was more consistent across multiple PSPA measures than it was across multiple MSW measures; indicating that the PSPA is a more reliable assessment of a participant's preference. As expected, the preference hierarchies established via staff report did not significantly correlate with either experimental procedure. However, the highest preferred items identified by both direct assessments tended to correlate with each other and with the highest preferred stimuli identified via staff report. Finally, the average amount of time it took to conduct the PSPA (16 min) was 2.3 times longer than the MSW average (7 min).

Although it is a potentially efficient assessment procedure, DeLeon and Iwata (1996) noted that a poignant limitation of the MSW preference assessment is that the highest preferred item is available during every experimental trial. Its availability typically leads to its selection across trials, at times to the full exclusion of other stimuli that, in its absence, might have been selected and could function as reinforcers. DeLeon and Iwata hypothesized that the high-preferred stimulus' tendency to compete with the selection of other available stimuli was responsible for less distinct, and consistent, rankings of less preferred stimuli (when compared to the rankings generated by the PSPA). Thus, they proposed that stimuli selected in the MSW format should be removed from subsequent MSW trials so that they could not interfere with the establishment of a preference hierarchy for less preferred stimuli. They then compared the results of PSPA, MSW, and MSW without stimulus replacement (MSWO) preference assessments. The results of their study indicated that the MSWO could produce distinct and consistent preference hierarchies (like the PSPA) and could be conducted in less than half the time it took to conduct a PSPA (like the MSW); effectively producing the advantages of the other two preference assessments without producing any of the previously noted drawbacks of said procedures.

One limitation of all of the preference assessments discussed thus far is that all require a therapist to interact with, and place what could be considered demands upon (i.e., prompts to make a choice), the participant. Additionally, all require the therapist to remove preferred stimuli from participants multiple times. If participants engage in problem behavior maintained by escape from demands or access to tangible items, it is possible that such procedures will evoke problem behavior. One preference assessment that was designed to reduce the probability of the occurrence of tangible and escape maintained problem behavior during the assessment is a free-operant (FO) derivation of the MSW format. In this assessment, an array of items are made available to the participant; who is allowed to engage with any, or all of them, for the duration of the assessment. During each session, data collectors score participant engagement with each item using 10-s intervals. A preference hierarchy is established by calculating, and comparing the percentage of, in-session item-engagement for each stimulus evaluated. Roane, Vollmer, Ringdahl, and Marcus (1998) evaluated a brief version (a single, 5-min, session) of the FO preference assessment and compared its results with those of a PSPA. Roane et al. found the FO preference assessment to be advantageous in that it generally produced fewer problem behaviors than the PSPA and required substantially less time than the PSPA to complete. However, like the MSW preference assessment discussed above, the FO did not produce a distinct hierarchy of preference for all of the stimuli evaluated. Instead, it was useful for identifying the highest preferred stimulus at any given time.

Reinforcer Assessments

Piazza, Fisher, Hagopian, Bowman, and Toole (1996) argued that preference assessments and reinforcer assessments are methodologically and conceptually distinct; noting that preference assessments generally evaluate a larger array of stimuli but do not establish the reinforcing properties of any. Whereas reinforcer assessments evaluate a much smaller array of stimuli but directly measure whether they are reinforcers by making their acquisition contingent upon a target response. In one experiment, Piazza et al. assessed the predictive quality of the PSPA by comparing the high-, moderate-, and low-preferred stimuli identified by the PSPA in a concurrent operant reinforcer assessment. They found that high-preferred stimuli functioned as reinforcers when competing against all other stimuli for all participants. They found the moderate-preferred stimuli functioned as reinforcers when competing against low-preferred stimuli for only 2 of 4 participants. Finally, they found that low-preferred stimuli did not function as reinforcers. Thus, their results provided some evidence that relative preference for stimuli (identified by the PSPA) is predictive of the efficacy of said stimuli as reinforcers.

Roscoe, Iwata, and Kahng (1999) compared high-preferred and low-preferred stimuli (as identified via a combination of the results of the PSPA and the Pace procedure) in a concurrent schedule free operant CRF reinforcer assessment and verified that high-preferred stimuli maintained higher rates of work than low-preferred stimuli for 7 of 8 participants. However, in a subsequent single operant CRF experiment, low-preferred stimuli maintained rates of responding similar to those of high-preferred stimuli in the concurrent operant arrangement for 6 of 7 participants. These results suggested that preference hierarchies, and concurrent operant reinforcer assessments, may not be indicative of the reinforcing effect (e.g., the rate of work) that low-preferred stimuli can maintain in some situations.

One limitation of Roscoe et al. (1999) was that they only evaluated the effect of low-preferred stimuli on response rate on a continuous schedule of reinforcement. Because stimuli that produce similar effects at low schedule requirements can produce differential effects at higher schedule requirements (Tustin, 1994), the results of Roscoe et al. cannot indicate whether high- and low-preferred stimuli are equally effective reinforcers at more effortful schedule requirements.

DeLeon, Frank, Gregory, and Allman (2009) examined whether stimuli at different levels in preference hierarchies established by a PSPA would differentially maintain responding at different levels of effort, as determined by a progressive ratio (PR) reinforcer assessment (Hodos, 1961), in accordance with the hierarchy established by the PSPA. Their results showed that higher preferred stimuli produced higher break points for 10 of 12 stimuli assessed across four participants; indicating that stimuli at different points in a preference hierarchy will sustain different amounts of work.

Because each assessment brings with it a unique set of strengths and limitations, the assessment that should be used for any given experiment is dependent upon idiosyncratic factors specific to the needs of that experiment. In their review of preference assessments, Hagopian et al. (2004) suggested that one consider contextual variables such as the nature of the targeted response, the nature of the stimuli being evaluated, the availability of other reinforcement, and recent access (or deprivation) to or from the stimuli to be evaluated prior to selecting a preference (or reinforcer) assessment. The experiment I conducted is relatively unique in that I compared the effect of contingent access to preferred, and contingent escape from aversive, sounds on human behavior. Thus, I needed a reinforcer assessment that could establish a preference hierarchy of access to, and escape from, sound. I also needed a reinforcer assessment that could produce an objective measure of the reinforcing value of access to, and escape from, sound. Finally, I needed a reinforcer assessment that could produce a means for equating the reinforcing value of access to sound with the reinforcing value of escape from sound.

Negative Reinforcer Assessments

As has been noted by Knighton, Bloom, Samaha, and Clark (2012), preference assessments of aversive stimuli bring with them methodological complications that preclude many of the assessments that have been validated for the assessment of preferred stimuli. One barrier for establishing a preference hierarchy of negative reinforcers is that negative reinforcement requires that a participant contact the target stimulus prior to emitting the target response. By contrast, positive reinforcement requires that an individual's experience with the target stimulus follow the targeted response. This procedural difference proves to be advantageous for positive reinforcer preference assessments because it allows participants to choose a single consequence from an array of concurrently available options. This is possible because the concurrent availability of multiple positive reinforcers does not preclude the assessment of the effect of a single stimulus presentation on future behavior. Conversely, the concurrent availability of multiple options of negative reinforcement, by necessity, requires that exposure to all targeted stimuli occur simultaneously and that continued exposure to all but one occur following a targeted response. The concurrent application of multiple independent variables at once limits conclusions about the effect of any single IV on response allocation alone. Thus, it would not be conceptually, or functionally, sound to establish preference hierarchies of aversive stimuli by pitting them in direct competition with each other (as is done in the vast majority of preference assessments for appetitive stimuli).

Because studies like DeLeon et al. (2009) (see also Glover, Roane, Kadey, and Grow 2008; and Penrod, Wallace, and Dyer, 2008) have demonstrated high correspondences between hierarchies of positive reinforcers established via PR reinforcer assessments and those of more traditional preference assessments, Knighton et al. (2012) hypothesized that the PR reinforcer assessment would also prove to be useful for establishing accurate hierarchies of aversive stimuli. This is because the PR reinforcer assessment can establish an objective hierarchy of reinforcing value among stimuli based upon the work requirements that each maintains but does not require that any specific stimulus be placed in direct competition with any other.

In their study, Knighton et al. (2012) conducted three different types of negative reinforcer assessments to establish whether or not certain sounds were aversive. Two adults diagnosed with a developmental disability and who required communication training served as their participants. Sessions were conducted in a room with tables, chairs, and a speaker (used to deliver the aversive sounds). The first assessment was a derivation of the PSPA and was used to rule out the possibility that target sounds could serve as positive reinforcers. Instead of pitting two target sounds against each other, they pitted the contingent presentation of a single sound against no sound at all. If a participant selected silence over the target sound five consecutive times across two separate settings, then it was included in subsequent experiments. After five aversive sounds had been identified via this procedure, each was assessed three times in a negative reinforcer PR assessment where response requirements (i.e., requests to terminate the sound) were increased by 150% after every reinforcement delivery. The schedule requirement prior to the last reinforcement in each session was labeled the "breakpoint." Hierarchies among stimuli were established by comparing the average break point of each stimulus (higher average breakpoints indicated more aversive stimuli and vice versa). Finally, the authors conducted an experiment to determine whether stimuli that produced high quality escape (HQE; i.e., high average break points during the PR reinforcer assessment) would maintain different rates of responding than stimuli that produced low quality escape (LQE). In order to do this, they used a multi-element design in which target responses provided escape from the highly aversive stimulus in one condition, the mildly aversive stimulus in another condition, and a preferred stimulus in a control condition. In the first phase, target responses were reinforced according to the average break point of the LQE. In the second phase responses were reinforced according to the average break point of the HQE.

The results of the PR reinforcer procedure produced a clear hierarchy of preference for one participant but not for the other. For the participant for whom a response hierarchy could not be established, differentiated responding was not seen in any phase of the experiment. For the participant for whom a preference hierarchy was established, response rates were not differentiated during the first phase (i.e., richer schedule) of the multi-element reinforcer assessment. However, when reinforcement was made contingent upon a leaner schedule, HQE maintained higher rates of responding than did LQE (extending the findings of Tustin, 1994 to negative reinforcement).

The preliminary results of Knighton et al. (2012) indicate that the PR negative reinforcer assessment procedure may produce a valid measure of the reinforcing value of escape from sound. Furthermore, the metric from which negative reinforcer value is established in this procedure is identical to the metric used to establish positive reinforcer value in a traditional PR reinforcer assessment procedure. Thus, the results of both procedures can be directly compared and negative reinforcer value can be equated with positive reinforcer value. As a result, we used PR reinforcer assessments to establish and equate the reinforcing value of preferred sound presentation and the reinforcing value of aversive sound removal during my experiment.

Purpose

The purpose of this project was to determine whether: (1) Stimuli manipulated in negative reinforcer PR assessments would produce similar breakpoints to stimuli manipulated in positive reinforcer PR assessments. (2) Participant behavior was differentially sensitive to parameter manipulations in positive parameter sensitivity assessments when sound was manipulated. (3) Participant behavior was differentially sensitive to parameter manipulations in negative parameter sensitivity assessments when sound was manipulated. (4) Participant sensitivity to parameter manipulation of positive reinforcement was different than participant sensitivity to parameter manipulations of negative reinforcement when sound was manipulated.

METHOD

Each participant participated in an MSWO preference assessment. Participants also participated in positive and negative sound preference assessments, PR reinforcer assessments, parameter sensitivity assessments, and posttest preference probes. The justification and procedures for each assessment are described in detail below.

Participants

A parameter sensitivity assessment of negative reinforcement could have a number of useful applications for skill acquisition and behavior reduction procedures for applied populations; provided we can demonstrate that there is a functional difference between positive and negative reinforcement. However, because convincing evidence of such a difference does not currently exist, because this study manipulated mildly aversive sounds, and because there was no clear benefit for the participants of this study, targeting a population with a developmental disability was not appropriate. Thus, we decided to work with a typically developing population.

We recruited three college students to participate in this study. Krista (female) was an 18-year-old undergraduate student majoring in elementary education. Lucy (female) was a 19-year-old undergraduate student also majoring in elementary education. Mike (male) was an 18-year-old undergraduate student majoring in aviation management. We paid participants $7.50/hour for their participation. Specifically, during the informed consent process, we informed participants that we would pay them for participating in this study but that payment was contingent upon their completion of all phases of the experiment. Then, we documented the cumulative amount of time that each participant spent with us in session rooms. Once a participant completed posttest preference probes we walked with them to a local automated teller machine (ATM) and withdrew $7.50 cash for every hour that they participated with us. We gave them the agreed upon amount of money once they signed a receipt stating the amount of time they participated, the nature of their participation, and the amount of money they received. The average amount of time that each participant participated in this study was 19 hours (range 15 – 21).

Setting

All sessions were conducted in a room containing at least 1 table and two chairs. Additionally, distractions were removed from the room during all sessions.

Volume

In order to ensure that sound manipulations did not harm our participants, all sounds presented in all phases of this study were five decibels quieter (80 dB; the volume of an active vacuum cleaner approximately 3 m away) than the minimum volume (85 dB) required to produce eardrum damage at prolonged durations according to the most conservative estimates available (i.e., those provided by the World Health Organization). The volume of all sounds was measured using a decibel reader app (Decibel 10^{th}®) on an iTouch® handheld computer from a distance of 0.5 m away from the sound source.

Reliability

Data collection procedures varied across assessments. Thus, the data collection procedure, and the method for calculating inter-observer agreement (IOA), will be described as each assessment is described.

MSWO Tangible Item Preference Assessment

We conducted a seven-item MSWO preference assessment for each participant to identify a low-preferred (but not aversive) stimulus to use during PR reinforcer assessments. During the MSWO assessment, the therapist placed an array of six or seven books, magazines, and/or toys approximately 1 m in front of a participant and approximately 10 cm apart and gave the instruction to, "pick one." After the participant approached an item the therapist immediately removed the others and allowed the participant to engage with the selected item for 30 s. The therapist then asked the participant to return the item. During subsequent presentations the therapist did not include any previously selected items. We ended each assessment when there were no items left or after no selections were made from the remaining items. The therapist conducted this assessment three times and collected data on the selection order of each stimulus. We established a preference hierarchy by comparing the average selection order for each item across the three assessments. The low-preferred item was the item with the lowest average selection order among items that had been selected all three times during the preference assessments. These assessments took approximately 10-20 min to conduct per participant.

Reliability for MSWO Tangible Item Preference Assessment

A reliability data collector independently collected data on stimulus selection order for 67% of all assessments conducted. We compared the stimuli registered by primary and reliability data collectors at each rank (i.e., 1st, 2nd etc.) and marked the ranking as either an "agreement" or a "disagreement." We calculated IOA by dividing the agreements by the sum of the agreements and disagreements and multiplying by 100. Data collectors agreed across 100% of the selections evaluated.

Sound Preference and Avoidance Assessments

Preferred sound assessment

This assessment was conducted to ensure that sounds manipulated in subsequent reinforcer assessments were preferred sounds. Specifically, we evaluated whether participants chose to listen to target sounds instead of silence. Prior to conducting this assessment we asked participants to tell us the name of their favorite song. We then typed the reported song into the "new station" bar of the "Pandora" website (Pandora is a website that creates personalized radio stations by compiling a playlist of songs that have similar musical properties to preferred songs reported by the listener). We then selected the first five songs of the newly created playlist. Thus, the sound pool we used in this assessment consisted of each participant's favorite song and an additional five songs that possessed some of the favorite song's musical properties.

Trials were conducted at a table with two chairs. Two sheets of paper were placed on the table. One sheet of paper had the word, "sound" printed on it and the other sheet of paper had the word “silence” printed on it. Prior to each trial the therapist said, “when you touch this,” simultaneously touched the “silence” paper, and then said, “nothing will change.” Following this prompt the therapist remained quiet for 30 s. Next, the therapist said, “when you touch this,” simultaneously touched the “sound” paper, and then said “you get sound.” Following this prompt the therapist turned on the sound for 30 s.

At the beginning of each trial the therapist prompted the participant to, “pick one.” The participant selected a consequence by touching one of the two pieces of paper. If the participant touched the “sound” paper then the therapist turned on the selected sound for 30 s. Following sound delivery, the therapist changed the location of “sound” and “silence” papers and began a new trial (e.g., if “sound” were on the left in the previous trial, the therapist would place it on the right for the subsequent trial). If the participant touched the “silence” paper during any trial the therapist remained quiet for 30 s, discarded the target sound, and then assessed a new sound. If the participant touched the “sound” paper three consecutive times then that sound became eligible for evaluation in subsequent positive reinforcer assessments.

Sound avoidance assessment

The purpose of this assessment was to ensure that sounds manipulated in subsequent negative reinforcer assessments were not actually preferred by participants. That is, we evaluated whether participants preferred to turn these sounds off rather than listen to them. The sounds that we evaluated consisted of the sounds used in Knighton et al. (2012) and included a crying baby, a honking horn, a fire alarm, and a variety of tones and static.

Prior to each trial the therapist turned on the target sound. The therapist said, “when you touch this,” simultaneously touched the “sound” paper, and then said, “nothing will change.” The therapist then remained quiet for 30 s while the sound played. Next, the therapist said, “when you touch this,” touched the “silence” paper, and said, “you get silence.” The therapist then turned off the sound for 30 s. At the onset of the trial the therapist turned the sound back on and prompted the participant to, “pick one.” If the participant picked the “silence” paper the therapist turned off the sound for 30 s. The therapist then turned the sound back on, changed the location of “sound” and “silence” papers, and began the next trial. If the participant ever chose the “sound” icon then the therapist discarded the target sound and presented a new sound during the subsequent trial. If the participant chose the “silence” icon for three consecutive trials then that sound became eligible for evaluation in subsequent negative reinforcer assessments.

Data collection and reliability

Primary data collectors collected data on the choices made by participants during all sound assessments by circling the word “sound” or “silence” on a data collection sheet. A reliability data collector collected IOA during 67% of all sound assessments. We calculated IOA by scoring agreements and disagreements between primary and reliability data collectors at every choice point of targeted assessments. Agreements for each assessment were divided by the sum of agreements and disagreements and multiplied by 100. IOA for all sound assessments was 100%.

Reinforcer and Parameter Sensitivity Assessments

Responses

Participants were required to solve 2-digit addition problems (e.g., 98 + 54) written on 12.7 cm x 17.8 cm pieces of paper. Specifically, participants picked up a piece of paper containing an addition problem from the top of a single stack (PR reinforcer value assessment) or from the top of either of two concurrently available stacks (parameter sensitivity assessment). The participant then solved the equation, wrote the answer under the equation, and handed the paper to the therapist. Each paper had the correct answer to the equation printed on its back. If the response was correct, the therapist either delivered the programmed reinforcer or prompted the participant to "pick one" (a new problem was available at the top of each stack of math problems) depending on whether or not the schedule requirement for that option had been met. If the response was incorrect the therapist prompted the participant to, "try again" and returned the paper to the participant. If the participant made a second error on a particular math problem, the therapist discarded the math problem at both options and prompted the participant to "pick one." The therapist responded to non-compliance (i.e., when a participant did not pick/attempt to solve a math problem) differently during each assessment. Thus, specific therapist responses to noncompliance are described in conjunction with the procedures of each subsequent assessment. Data collectors collected data on the number of correct response completions made by each participant during each session. Additionally, data were collected on the duration of time spent working on math problems at each of the response options during the parameter sensitivity assessment.

PR Reinforcer Value Assessment

We conducted these assessments to establish and equate the reinforcing value of the target positive and negative reinforcers. We equated the value of positive and negative reinforcers by comparing the average breakpoint of the positive reinforcer with the average breakpoint of the negative reinforcer. In order to do this, we conducted a PR reinforcer value assessment for each of three preferred and three aversive sounds identified during previous sound assessments.

The sounds that we used as positive and negative reinforcers during subsequent positive and negative parameter sensitivity assessments were the aversive and preferred sounds that produced the closest average breakpoints (i.e., average breakpoints that fell within 1 PR step). If no average breakpoints produced by preferred sounds had fallen within one PR step of the average breakpoints produced by any of the aversive sounds, then additional sounds would have been evaluated until two sounds with similar average breakpoints had been found. This was never necessary.

During each session, participants sat at a table with a stack of addition problems. The therapist reinforced task completion (with 30 s of access to, or escape from, sound) according to a PR schedule for which the response requirements increased by 150% after every reinforcer delivery. For example, the first reinforcer was delivered after one response, the second reinforcer after two responses, the third after three, the fourth after five, the fifth after eight, and so forth.

The therapist began each session by stating, “you don’t have to do anything you don’t want to do. If you’d like, you can work to earn (remove) sound.

Otherwise, you can play with this (point to the low-preferred item; similar to the procedure used in Keyl-Austin, Samaha, Bloom, & Boyle, 2012), or do nothing at all."

Each session ended once the participant did not emit a target response for one full min (after the first 5 min had elapsed). Including this 5 min criterion was meant to decrease the discriminability of a more global contingency that never responding would decrease the total duration of any given assessment. We conducted this assessment three times for each sound. Additionally, we conducted three no-consequence sessions in which participants were free to complete math problems at will, but received no consequence for doing so. These no-consequence sessions served as the control for this assessment. We established the reinforcing value of access to, or escape from, each sound by calculating the average breakpoint produced by each.

Reliability for PR reinforcer value assessments. We collected IOA data for 54% of all PR reinforcer value assessments conducted. We calculated IOA scores by comparing the number of completed responses recorded by primary and reliability data collectors during each session. We divided the smaller number of responses by the larger number of responses and multiplied by 100. The average session IOA score for all PR reinforcer value assessments was 99.2% (range 89.5% to 100%).

Parameter Sensitivity Assessment

We conducted parameter sensitivity assessments of target responses maintained by both positive and negative reinforcement. During each assessment, different values of various parameters of reinforcement were pitted in direct competition with each other in a concurrent operant choice paradigm. If favorable dimensions of one parameter produced greater than 50% response allocation toward it when competing with the favorable dimension of another parameter, then the parameter that produced more responding was considered the more influential parameter of reinforcement. We established a hierarchy of influential parameters (most-to-least) by comparing the number of sessions in which each parameter produced greater than 50% response allocation. The parameter that produced greater than 50% response allocation across the most number of sessions was considered the most influential parameter of reinforcement. Following the completion of all parameter sensitivity assessments, we compared the hierarchies produced by both positive and negative reinforcer processes. Additionally, we compared differences in the percentage of time allocated toward the favorable dimension of each parameter.

Each assessment was based on the procedures outlined by Neef and Lutz (2001a) and consisted of baseline and assessment conditions. The assessment occurred at a table with three chairs; one for the participants, one for a trained session therapist, and one for a trained data collector. We placed two laptop computers in front of the data collector; one controlled target sounds and the other timed work intervals and time spent in reinforcement. The session therapist sat across from the participant and faced him/her.

Two rectangular pieces of paper were placed approximately 0.5 m in front of the participant and 30 cm apart. These pieces of paper had arbitrary symbols printed on them that corresponded to specific magnitude and immediacy parameter values. Additionally, the color of these papers corresponded to specific reinforcer schedule values (i.e., "green" for rich schedules of reinforcement and "red" for lean ones). We placed a stack of addition problems on each sheet of paper. The addition problems visible at both options were identical. For example, the math problem "45 + 64" might have been on the top of both stacks of math problems. When a participant removed the math problem from the top of one of the stacks, the therapist immediately removed the corresponding math problem from the top of the other stack. Thus, after the participant solved the presenting math problem a new math problem (e.g., "19 + 84") was visible on the top of both stacks of math problems.

When tasks were presented the therapist gave participants 10 s to choose one of the options. If the participant did not make a selection after 10 s, the therapist prompted him/her to "pick one" and gave him/her an additional 10 s to make a selection. Incorrect or incomplete responses produced the vocal prompt to, "try again." Two consecutive errors produced the replacement of math problems at both options and the vocal prompt, "pick one." Task completion before a scheduled interval elapsed produced new problems at both options and the vocal prompt, "pick one." Task completion after a scheduled interval elapsed produced the scheduled reinforcer (i.e., sound presentation or removal).

All sessions were 10 min. Prior to each session the therapist provided the following instructions: "You can work on either option to earn (or escape) sound. During each session, try to be sensitive to differences between the two options while you work to produce desirable consequences." The therapist then provided participants with a forced choice exposure to each contingency (on an FR1 schedule of reinforcement). When reinforcement rate was one of the variables manipulated, the forced choice consisted of the vocal prompt, “when you work at this option for this average amount of time.” Following this prompt, participants began solving math problems. After the mean value of the target schedule had elapsed (i.e., 15 s for *high* rates of reinforcement and 45 s for *low* rates of reinforcement), the therapist said, “you get this” and delivered the programmed reinforcer. Following pre-session exposure to each contingency the therapist said, “pick one” and began the session.

Response measurement and interval timing. Because some math problems could take more time to complete than other math problems it was possible for a participant to spend more time at one response option than the other but to make fewer selections of said option. Thus, the amount of time participants allocate toward each response option (in relation to the time spent at the other option) was the primary dependent variable. Reinforcer consumption time was omitted from all analyses of response allocation so that larger durations of reinforcement scheduled at one of two options did not artificially inflate representations of time allocated toward that option. We calculated the percentage of time spent at each option by dividing the total amount of time spent at one option by the total amount of time spent at both options and multiplying by 100.

In order to facilitate conducting each session with high procedural fidelity and accurate data collection, one of our researchers wrote a data collection and reinforcer delivery program using an electronic sketchbook provided by Processing®. Using this program, data collectors could toggle one of two available “response” buttons. Each button corresponded to math problems completed at each option. A single toggle illuminated a button and was meant to indicate that a math problem at the button’s corresponding location had been selected. A second toggle turned the button off and was meant to indicate that the math problem had been completed.

In addition to collecting data on response allocation, this program timed the intervals of the VI schedules used at each option and signaled to the data collector when a target response at either option should be reinforced by illuminating one (or both) of two buttons with the color green. Each button had the letters “Sr” written in it. Once a participant picked a problem that corresponded to an illuminated “Sr” button (or if a button was illuminated while a participant was already working on a corresponding math problem), the data collector gently kicked the therapist’s leg under the table. Following completion of the target response the therapist covered the math problems at both options in order to signal to the participant that reinforcement had been obtained. Contingent upon this signal, the data collector pressed the green “Sr” button and delivered reinforcement according to the prescribed dimensions of each parameter. Once the green “Sr” button was pressed it turned orange and the computer program stopped the timers for VI intervals and started the timer for the prescribed reinforcer access time. Once this timer counted down to “0,” the computer program turned off the “Sr” button and resumed timing the schedule intervals at each option. The data collector simultaneously ceased to deliver reinforcement and the therapist removed his hand from the table and prompted the participant to “pick one.” After 10 min had elapsed (including consumption time), the data collector signaled to the therapist and participant that the session was over.

Reliability for parameter sensitivity assessment. A reliability data collector independently collected data on participant choices, participant task completion, and reinforcement delivery for 31.9% of all sessions. We calculated IOA by dividing each session into 10 s bins. We then compared the responses scored by primary and reliability data collectors in each bin. Specifically, we divided the smaller number of responses scored by the larger number and multiplied by 100. If neither data collector scored a response in a bin, we scored 100% agreement for that bin. We then summed bin IOA scores and divided by the total number of bins in a session. The mean IOA score for "toggle on" was 93.8% (range 73.3% to 100%). The mean IOA score for "toggle off" was 94% (range 76.7% to 100%). The mean IOA score for "Sr" was 92.5% (range 70% to 100%).

Procedural fidelity. An independent data collector evaluated session procedural fidelity for 25.2% of all sessions using a "yes/no" system (see Appendix A for a sample data collection sheet). Specifically, data collectors scored whether the therapist put the correct symbols under each stack of math problems, whether the therapist programmed the correct schedules and parameters of reinforcement into the computer program for each option, whether the therapist withheld the target reinforcer at the beginning of each session, and whether each session lasted 10 min (+/- 5 s). Correct responses for each indicator produced a "yes" for that indicator and incorrect responses for each indicator produced "no" for that indicator. Additionally, data collectors used a tally system to score "yes" and "no" for reinforcer delivery, reinforcer removal, and math problem removal. Specifically, each time the therapist removed a math problem from the stack opposite of the stack from which the participant made a selection, the data collector tallied a "yes." If the therapist did not remove the corresponding math problem, the data collector tallied a "no." Similarly, each time a reinforcer was delivered within 3 s of when it was programmed to be delivered the data collector tallied a "yes." Likewise, each time a reinforcer was removed within 3 s of when it was programmed to be removed the data collector tallied a "yes." If reinforcers were not delivered (or removed) within 3 s of when they were programmed to be delivered (or removed), the data collector tallied a "no." We scored session procedural fidelity by dividing the number of "yes" scored by the sum of "yes" and "no" and multiplied by 100. The mean procedural fidelity score for parameter sensitivity assessments was 99.1% (range 91% to 100%).

Parameter manipulations. The parameters that we manipulated in this assessment were similar to those manipulated in Neef et al. (2001a). Specifically, we manipulated reinforcer rate, reinforcer magnitude, and reinforcer delay. We did not manipulate reinforcer quality in this assessment because a concurrent operant arrangement requires that two reinforcement options be simultaneously available. As has previously been noted, making high quality escape and low quality escape concurrently available would require the simultaneous presentation of two different aversive sounds. Additionally, escape from only one of those sounds could be provided contingent upon schedule completion. Thus, this specific experimental arrangement was not ideal for evaluating the effect of the quality parameter of negative reinforcement on response allocation. However, we were able to hold quality constant across assessments by selecting positive and negative reinforcers that produced identical (or similar) average breakpoints during the PR reinforcer quality assessment. Thus, differences in qualities of the target positive and negative reinforcer should not have been a confounding variable for this experiment. Each potential parameter manipulation is outlined in detail below.

We manipulated reinforcer rate (R) by changing the schedule of reinforcement at each response option. All schedules were VI schedules of reinforcement. Schedule values were generated using the equation outlined by Fleshler and Hoffman (1962) with 8 intervals. Intervals were randomly selected with replacement. *Low* rates of reinforcement were set at a VI 45 s schedule of reinforcement. *High* rates of reinforcement were set at a VI 15 s schedule of reinforcement. Because Mace et al. (1996) suggested that humans may be insensitive to schedule changes without adjunct procedures to increase the discriminability of said changes, We assigned a specific color to each schedule manipulated in this experiment (Hanna, Blackman, & Todorov, 1992). Thus, rich schedules were paired with the color green and lean schedules were paired with red.

We manipulated reinforcer magnitude (M) by altering the duration of access to, or escape from, target sounds. *Low* magnitude reinforcement was defined as 10 s of access to, or escape from, a target sound. *High* magnitude reinforcement was defined as 30 s access to, or escape from, a target sound. Choices that produced low magnitude reinforcement were paired with a distinctive symbol (that was printed on the colored paper under each stack of math problems). Similarly, choices that produce high magnitude reinforcement were paired with a different distinctive symbol.

We manipulated reinforcer delay (D) by altering the delay to reinforcement following schedule completion. *Immediate* delivery was defined as the contingent presentation, or removal, of the target sound 0 s after schedule completion had occurred. *Delayed* delivery was defined as the contingent presentation, or removal, of the target sound 30 s after schedule completion had occurred. During the 30 s delay, the therapist covered the index cards at both options so that participants could not respond during delay periods. Choices that produced immediate and delayed reinforcement were each paired with a distinctive symbol.

Baseline. During this condition we pitted favorable (i.e., immediate, high rate, or high magnitude) versus unfavorable (i.e., delayed, low rate, or low magnitude) values of a single reinforcement parameter against each other in a choice paradigm. All other parameter values were identical. Prior to beginning this condition we provided participants with a series of verbal instructions to expedite their learning process (Mace et al., 1994; Takahashi & Iwamoto, 1986). In these instructions, we: (1) explained the difference between interval schedules and the PR schedules that they had become familiar with, (2) used a "mailman delivering mail to your mailbox" metaphor to emphasize the nature of interval schedules, (3) explained what a variable (as opposed to fixed) schedule was, (4) explained that the schedules at each option were completely independent of each other, (5) pointed out that dimensions of each parameter corresponded to the symbols under each stack of math problems, (6) explained that the only programmed differences between the two schedules were the ones that we would pre-expose them to prior to each session, and (7) emphasized that all other parameters were kept constant.

We conducted baseline sessions for each parameter until participants allocated more than 50% of their responses toward the favorable option for three consecutive sessions. We counterbalanced the location of the favorable option across sessions. This was done to ensure that participants were sensitive enough to variations of a single parameter to choose the favorable option when all other variables were constant. Participants who did not demonstrate this sensitivity would not have been allowed to participate in this study.

Test. During this assessment, preferable dimensions of each parameter were pitted against preferable dimensions of every other parameter at least three times (or until stability, determined via visual inspection, was established). For example, during a negative reinforcer parameter assessment, the participant worked to remove the presence of an aversive sound. When reinforcer rate and immediacy were compared, one choice produced a high rate of sound removal and the other choice produced a low rate of sound removal. However, the choice that produced a high rate of sound removal only produced said sound removal after a 30 s delay. The other option produced a low rate of sound removal but produced it immediately. The other parameter (i.e., magnitude) was held constant at both options. The location of each favorable parameter was counterbalanced across sessions.

Table 1 outlines the different parameter manipulations that occurred during each assessment. In order to control for differences in overall access to reinforcement that could result from parameter manipulations, we selected parameter values that would produce the same proportion of reinforcement (i.e., 0.4) at both options during each test if a participant responded exclusively on either option (see Table 2).

Posttest Preference Probes

In his response to Baron and Galizio (2005), Staats (2006) suggested that differences between positive and negative reinforcement processes might not be found in the effect that they have on a target response, but could perhaps be found in the effect of the processes on collateral responses produced by the establishing operations (EO; Laraway, Snycerski, Michael, & Poling, 2003) that establish target consequences as reinforcers. Specifically, when discussing the effects of negative reinforcement, Staats reasoned that an individual must be exposed to an aversive stimulus before he/she will be motivated to escape from it. Conversely, he suggested that exposure to the EOs of positive reinforcement does not entail exposure to aversive stimulation and would not necessarily create an aversive situation. Thus, when considering behavior under the control of negative reinforcement, Staats suggested that collateral behavior (i.e., non-targeted avoidance responses evoked in the presence of an aversive stimulus) would eventually be evoked by experimental conditions that consistently generated opportunities for negative reinforcement to occur. Conversely, experimental conditions that consistently produced positive reinforcement would evoke approach responses.

As a thought experiment, Staats (2006) asked us to imagine a scenario in which two rats are taught to emit an identical target response (i.e., a bar press) in two different operant chambers. In the first operant chamber only positive reinforcement is used. In the second operant chamber only negative reinforcement is used. In both cases, the rats learn to emit the target response. Despite this fact, Staats suggests that the effect of the two conditioning procedures is not identical. To exemplify how, he suggested that experimenters could place each rat outside of an open door next to its respective experimental chamber. Thus, either rat could enter, or not enter, the chamber. Staats hypothesized that the rat that had worked for positive reinforcement would enter its chamber but that the rat that worked for negative reinforcement would not.

Although each rat's choice in Staats' thought experiment reflects a choice that most would agree to be logical, it does not reflect the actual choices of actual rats from an actual experiment. Thus, the purpose of these posttest preference probes was to provide our participants with choices that were analogous to the choices presented to the rats in Staats' thought experiment. We did this to determine whether, if given a choice, our participants would choose to work in the positive reinforcement paradigm we created in our study or in the negative reinforcement paradigm we created in our study.

Upon completion of all parameter sensitivity assessments, we asked participants to choose between working in positive or negative reinforcement paradigms. Prior to each choice we described the specific parameters of reinforcement available at each option (e.g., "when you work at this option for an average of 15 s, you will get 30 s of reinforcement following a 30 s delay). We then asked them if they wanted to work to produce positive reinforcement (i.e., the preferred song) or negative reinforcement (i.e., escape from the aversive sound). If participants chose negative reinforcement the therapist turned on the aversive sound and said, "pick one." If participants chose positive reinforcement the therapist simply said, "pick one." Subjects could then work at either option to earn reinforcement.

The probe ended after subjects earned a single reinforcer at either option. We ended this condition after participants made three choices for each of the three parameter sensitivity assessment conditions (i.e., R vs. M, D vs. R, and M vs. D).

Reliability for posttest preference probes. An independent observer recorded participant choices for 67% of all preference probes conducted. We compared the choices recorded by primary and reliability data collectors and calculated IOA by dividing agreements by the sum of agreements and disagreements and multiplying by 100. The mean IOA for posttest preference probes was 100%.

RESULTS

MSWO Tangible Item Preference Assessment

The results of each participant's MSWO preference assessment are shown in Figure 1. Krista's low-preferred item was the notepad, Lucy's was a Dora The Explorer® picture book, and Mike's was a plastic container full of small plastic snakes.

Sound Preference and Avoidance Assessments

The results of each participant's sound preference avoidance assessments are shown in Figure 2. Krista's data are shown in the top panel, Lucy's in the middle panel, and Mike's in the bottom panel. Krista's preferred sounds were Never Getting Back Together (Taylor Swift), Need You Now (Lady Antebellum), All-American Girl (Carrie Underwood), Bless This Broken Road (Rascal Flatts), Teardrop On My Guitar (Taylor Swift), and Give Your Heart a Break (Demi Lovato). Krista's aversive sounds were bagpipes, yodeling, white noise, traffic, 8-bit, alternating tones, crying baby, and arrhythmic tones.

Lucy's preferred sounds were Sail (AWOLNation), Shake Me Down (Cage The Elephant), Sleepless Nights (Faber Drive), People (AWOLNation), Jump On My Shoulders (AWOLNation), and Fighting In A Sack (The Shins). Lucy's aversive sounds were yodeling, white noise, rock-loop, crying baby, bagpipes, vacuum, traffic, 8-bit, alternating tone, and arrhythmic tone.

Mike's preferred sounds were Day and Night (Kid Cudi), Loose Yourself (Eminem), Superstar (Lupe Fiasco), Run This Town (Jay-Z), Feel Good Inc (Gorrillaz), and American Boy (Estelle). Mike's aversive sounds were bagpipes, crying baby, vacuum, 8-bit, arrhythmic tones, traffic, white noise, and yodeling.

PR Reinforcer Value Assessments

The results of each participant's PR reinforcer value assessment are shown in Figure 3. Krista's data are in the left panel, Lucy's data are in the middle panel, and Mike's data are in the right panel. Krista produced a mean breakpoint of 38 (range 8-93) for Never Getting Back Together, of 8 (range 5-12) for Need You Now, of 7 (range 2-12) for All-American Girl, of 5 (range 3-8) for white noise, of 4 (range 1-5) for vacuum, of 6 (range 3-8) for traffic, and of 0 (range 0-0) for the no-consequence control. The closest average breakpoints were produced by All-American Girl (7) for positive reinforcement and traffic (6) for negative reinforcement. Thus, we selected the contingent presentation/removal of these sounds as Krista's target positive and negative reinforcers for the remainder of the study.

Lucy produced a mean breakpoint of 5 (range 1-12) for Sail, of 3 (range 0-5) for Shake Me Down, of 3 (range 2-5) for Jump On My Shoulders, of 4 (range 2-8) for white noise, of 5 (range 0-12) for crying, of 1 (range 0-3) for traffic, and of 0 (range 0-0) for the no-consequence control. Identical average breakpoints were produced by Sail (5) for positive reinforcement and crying (5) for negative reinforcement. Thus, we selected the contingent presentation/removal of these sounds as Lucy's target positive and negative reinforcers for the remainder of the study.

Mike produced a mean breakpoint of 54 (range 27-93) for Day and Night, of 24 (range 18-27) for American Boy, of 21 (range 18-27) for Run This Town, of 36 (range 18-62) for white noise, of 16 (range 12-18) for crying, of 22 (range 12-27) for vacuum, and of 0 (range 0-0) for the no-consequence control. The closest average breakpoints were produced by Run this Town (21) for positive reinforcement and vacuum (22) for negative reinforcement. Thus, we selected the contingent presentation/removal of these sounds as Mike's target positive and negative reinforcers for the remainder of the study.

Parameter Sensitivity Assessments

Baseline

The final three sessions of each participant's baseline sessions of the parameter sensitivity assessment are shown in Figure 4. Krista's data are in the top panel, Lucy's data are in the middle panel, and Mike's data are in the bottom panel. Because within-session responding was symmetrical (i.e., if a participant responded on the left option 54% of the time then, by necessity, he/she responded on the right option 46% of the time), we only graphed each participant's percentage of responding toward the favorable options (i.e., responding toward high rate, high magnitude, or immediate reinforcement) for each session. Additionally, we graphed both positive and negative sessions together to facilitate their comparison. Negative reinforcement sessions are graphed with closed data points and positive reinforcement sessions are graphed with open data points. All three of our participants allocated greater than 50% responding toward the favorable option, during both positive and negative reinforcement baselines, for three consecutive sessions. Thus, all were included in subsequent parameter sensitivity assessments.

Test

The results of Krista's parameter sensitivity assessment are shown in Figure 5. The top panel shows the assessment for positive reinforcement, the middle panel shows the assessment for negative reinforcement, and the bottom panel compares Krista's responding toward preferred options in positive and negative assessments. The text to the right of these graphs shows the order of influence that each parameter evaluated had on Krista's responding.

For both positive and negative reinforcement, Krista was most influenced by manipulations in the delay parameter (followed by magnitude, then rate). When rate competed with magnitude, Krista responded toward the favorable magnitude option 59.3% (range 57% - 63%) of the time for positive reinforcement and 80.7% (range 79% - 82%) of the time for negative reinforcement. When delay competed with rate, Krista responded toward the favorable delay option 75.7% (range 61% - 86%) of the time for positive reinforcement and 86.3% (range 85% - 88%) for negative reinforcement. When rate competed with magnitude Krista responded toward the favorable delay option 81% (range 78% - 83%) of the time for positive reinforcement and 79.7% (range 79% - 100%) of the time for negative reinforcement.

Lucy's results are shown in Figure 6. For positive reinforcement Lucy was most influenced by manipulations of the magnitude parameter (followed by rate, then delay). Conversely, for negative reinforcement, Lucy was most influenced by manipulations of the delay parameter, (followed by magnitude, then rate). When rate competed with magnitude, Lucy responded toward the favorable magnitude option 76.7% (range 62% - 93%) of the time for positive reinforcement and 72.7% (range 59% - 92%) of the time for negative reinforcement. When delay competed with rate, Lucy responded toward the favorable rate option 70% (range 60% - 83%) of the time for positive reinforcement. For negative reinforcement, Lucy responded toward the favorable delay option 95% (range 91% - 97%) of the time. When magnitude competed with delay, Lucy responded toward the favorable magnitude option 76.3% (range 70% - 87%) of the time for positive reinforcement. For negative reinforcement, Lucy responded toward the favorable delay option 83.3% (range 78% - 87%) of the time.

Mike's results are shown in Figure 7. For both positive and negative reinforcement, Mike was most influenced by manipulations of the magnitude parameter (Followed by rate, then delay). When rate competed with magnitude, Mike responded toward the favorable magnitude option 68% (range 57% - 82%) of the time for positive reinforcement and 65% (range 63% - 69%) of the time for negative reinforcement. When delay competed with rate, Mike responded toward the favorable rate option 99% (range 97% - 100%) of the time for positive reinforcement and 94% (range 82% - 100%) of the time for negative reinforcement. When magnitude competed with delay Mike responded toward the favorable magnitude option 100% of the time for both positive and negative reinforcement.

Posttest Preference Probes

The results of the posttest preference probes are shown in Figure 8. Krista's data are shown in the top panel, Lucy's in the middle panel, and Mike's in the bottom panel. All three subjects chose to work in a context of positive reinforcement (over negative reinforcement) 100% of the time.

DISCUSSION

We conducted a series of reinforcer assessments meant to establish and equate the reinforcing value of the contingent presentation and removal of two target stimuli that belonged to the same stimulus class (i.e., sound). We did this so that we could evaluate whether different reinforcement processes (i.e., positive and negative) would influence human behavior differently when identical parameter manipulations were made across both processes.

Our results suggest that, for one participant (Mike), parameter manipulations of positive and negative reinforcement processes influenced behavior in identical ways. For another participant (Krista), this same conclusion might be drawn; however, more tentatively. Although the hierarchy of influential parameters of reinforcement did not change across reinforcement processes for Krista (i.e., 1. Delay 2. Magnitude 3. Rate), the more influential parameter appeared to produce a larger response bias for behavior maintained by negative reinforcement for two of the three assessment conditions (when compared to behavior maintained by positive reinforcement). Specifically, when favorable dimensions of delay competed with favorable dimensions of rate, Krista allocated roughly 10% more responding toward the favorable delay option in the negative reinforcement tests than in the positive reinforcement tests. Similarly, when favorable dimensions of rate competed with favorable dimensions of magnitude, Krista allocated roughly 20% more responding toward the favorable magnitude option in the negative reinforcement tests than in the positive reinforcement tests. Thus, for Krista, even though the hierarchy of influential parameters remained the same across processes, favorable dimensions of magnitude and delay appeared to produce a larger bias for responding maintained by negative reinforcement when compared to responding maintained by positive reinforcement. However, because we did not evaluate her sensitivity to parameter manipulations of other positive and negative reinforcers (with identical reinforcing values), it is not possible to determine whether the observed bias was a function of differences in reinforcement process, or simply a function of differences in the effect of the specific stimuli manipulated.

Finally, for one participant (Lucy) the most influential parameters changed according to the reinforcement process. Specifically, when behavior was maintained by positive reinforcement then reinforcement magnitude had the most influential effect on participant behavior (followed by rate, then delay). Conversely, when behavior was maintained by negative reinforcement then delay to reinforcement had the most influential effect on participant behavior (followed by magnitude, then rate).

Lucy's results are important because they demonstrate that, for at least some individuals, positive and negative reinforcement processes may influence behavior differently. Thus, Lucy's results highlight one potential disadvantage of defining positive and negative reinforcement as the contingent presentation/removal of a *condition* or *context* instead of the contingent presentation/removal of a *stimulus*. On the one hand, the former definition allows us to equate positive and negative processes and allows us to use a single term to describe all environmental changes that result in an improvement in the state-of-being of an individual and, thus, result in an increase in the future probability of the behavior that preceded it. On the other hand, such a definition could potentially mask the possibility that identical manipulations of identical parameters of both processes do not always produce identical effects. Because little research has compared positive and negative reinforcement, it is possible that other differences could exist as well. Thus, it seems as though the parsimony gained by reducing positive and negative reinforcement to a single process might not justify the technical precision lost by eliminating the distinction.

For example, If a practitioner were to assume that positive and negative reinforcement are identical processes (as is suggested by Michael, 1975), then he/she may have assumed that, for someone like Lucy, magnitude, and not rate, was the most influential parameter of negative reinforcement after conducting a positive reinforcement parameter sensitivity assessment. If this practitioner were to design an intervention for negatively reinforced problem behavior (e.g., aggression) under this assumption, then he/she would manipulate dimensions of magnitude to alter the frequency of said problem behavior. Unfortunately, as was shown by Mace et al. (1996), manipulating dimensions of less influential parameters of reinforcement may not always change response allocation patterns. Thus, it is possible that the programmed intervention would be ineffective; even if it would have otherwise been effective had decisions about which parameters to manipulate had not been based on a faulty assumption (i.e., that behavior responded to manipulations of positive reinforcement in the same way that it responded to manipulations of negative reinforcement).

In general, Lucy's results suggest that, for some individuals (but perhaps not others), the positive reinforcement process can influence behavior in different ways than the negative reinforcement process. Her results may provide empirical justification for future research on negative reinforcement in a number of applied areas. For example, researchers could evaluate whether the results of parameter sensitivity assessments that exclusively manipulate positive reinforcement can be useful informants of behavior interventions for negatively reinforced problem behavior. Specifically, researchers could conduct positive and negative reinforcer parameter sensitivity sound assessments for individuals who engage in escape-maintained problem behavior. Then, for participants that demonstrated differential sensitivity across reinforcement processes, researchers could evaluate the effectiveness of two near-identical interventions (i.e., FCT without extinction in which favorable dimensions of reinforcement are provided for communication and unfavorable dimensions for problem behavior). The only difference between these two interventions would be the specific parameter manipulated (i.e., the most influential parameter of positive reinforcement for one intervention and the most influential parameter of negative reinforcement in the other).

If only the treatment based on the negative reinforcer parameter sensitivity assessment were effective, or if it was more effective than the other, then we would have evidence that the results of positive reinforcement parameter sensitivity assessments should not inform treatments of negatively reinforced problem behavior. If neither treatment were effective, then we would have evidence that parameter sensitivity assessments of arbitrarily selected reinforcers, in general, are not valid informants of behavior reduction interventions. If both treatments were equally effective, then we would need to evaluate whether parameter sensitivity assessments are necessary at all. Specifically, we would need to evaluate whether it is possible to suppress problem behavior by manipulating any parameter of reinforcement (regardless of its relative influence). Although the results of Mace et al. (1996) suggest that manipulating parameters of less-influential parameters of reinforcement may not be effective, they did not hold dimensions of the most influential parameter constant across options in their experiment. Thus, more research on the matter is required.

In addition to the lines of inquiry suggested above, future researchers could replicate and extend these findings to a larger, and/or different population, and could include manipulations of response parameters (i.e., effort) into the assessment. It might also be important to determine whether individuals are sensitive to the same parameter manipulations when different qualities (i.e., high, medium, & low) of positive and negative reinforcement are manipulated. Additionally, it could be useful to determine whether individuals are most influenced by the same parameter manipulations in avoidance paradigms as they are in escape paradigms. Furthermore, it could be beneficial to determine whether negative reinforcement affects skill acquisition and discrimination learning differently than positive reinforcement. Finally, the studies conducted by Neef and colleagues demonstrating the non-effect of medication on the impulsivity of children diagnosed with ADHD might need to be reconsidered because the medication might decrease a child's impulsivity in escape or avoidance paradigms even when it does not decrease said child's impulsivity when positive reinforcement contingencies are manipulated.

It is interesting to note that, for Mike and Krista, the highest quality positive sound reinforcers produced considerably higher break points than the highest quality negative sound reinforcers during their respective PR reinforcer value assessments. Although it is possible that the contingent presentation of high-quality preferred sounds can maintain responding at a larger response effort than the contingent removal of high-quality aversive sounds, such a conclusion should not be drawn from data produced by this investigation.

There are two reasons for this. First, we only evaluated the reinforcing value of the contingent presentation/removal of three sounds for each reinforcement process. Given the range of positive and negative sound reinforcers that *could* have been selected, it is improbable that the range of reinforcing qualities produced by the sounds manipulated in this experiment is representative of the range of reinforcing qualities that would be produced if the reinforcing effect of the contingent presentation/removal of all preferred and aversive sounds were individually evaluated.

Second, we used each participant's favorite song, as well as other songs that shared certain musical properties with each participant's favorite song, during the positive PR reinforcer value assessments. Conversely, we selected aversive sounds for the negative PR reinforcer value assessments without asking each participant which sounds they found most aversive; making the selection process for aversive sounds a bit more arbitrary than the selection process for preferred sounds. Thus, it is not surprising that some preferred sounds produced higher average breakpoints than the aversive sounds manipulated in this experiment.

Although posttest preference probes were not the focus of this dissertation, it is interesting to note that, when given a choice, all three of our participants chose to work for positive reinforcement to the full exclusion of negative reinforcement. Even though these results may be somewhat intuitive, they lend credence to the argument made by Staats (2006) when he suggested that additional differences between the positive and negative reinforcement processes might be found in the effect that the conditions surrounding their occurrence have on non-targeted responses; specifically, responses controlled by a differential preference for contexts in which positive reinforcement is obtained (over those in which negative reinforcement is obtained).

Even though we agree with the sentiment of Michael's (1975) and Baron and Galizio's (2005) argument that emphasizing reinforcement process can be distracting and that focus should instead be placed on the pre- and post-change variables that establish any given consequence as a reinforcer, it may be that there are fundamental differences between positive and negative processes and it may be that those differences have real-world implications.

We have attempted to exemplify some potential implications of the results of our parameter sensitivity assessments in the paragraphs above. With respect to the results of our posttest preference probes, our results may support the notion that teachers and behavioral clinicians should, whenever possible, first attempt to shape the behavior of their students/clients with positive reinforcement before reverting to negative reinforcement (when arbitrarily selected reinforcers are used to shape behavior). Although positive reinforcement is not synonymous with "good" (nor negative reinforcement with "bad") and we acknowledge that it is possible to make the EOs of positive reinforcement aversive (e.g., by exposing individuals to extreme states of deprivation), the EOs of positive reinforcement do not *have* to be aversive (i.e., they do not have to motivate individuals to act to escape from them once they have been contacted). Conversely, by necessity, EOs of negative reinforcers *must* be aversive.

In our experiment, despite the fact that the reinforcing value of target positive and negative reinforcers were similar once participants were exposed to relevant EOs, and despite the fact that participants were exposed to positive and negative EOs for equal amounts of time while in session, the conditions surrounding positive reinforcement were more preferred than the conditions surrounding negative reinforcement for all three of our participants. We suspect that this was because choosing to work for negative reinforcement would have required experimenters to expose participants to aversive stimulation prior to removing it, whereas choosing to work for positive reinforcement would not require participants to contact aversive stimulation at any point in time.

These results may be relevant to a number of applied situations because it is not uncommon for teachers and other behavioral practitioners to artificially create environments (i.e., act to produce EOs for targeted responses) in which the consequences that they can manipulate will function as reinforcers. If these teachers and practitioners are taught that positive and negative reinforcement are identical processes that simply describe a contingent improvement in an individual's state of being, then it may become more difficult for them to discriminate the difference between creating EOs by exposing a child to aversive stimulation and creating EOs by withholding preferred stimulation.

A few limitations of this experiment should be noted. First, participants were exposed to the target positive and negative reinforcement for a considerable amount of time (participants worked in this experiment for between 15 and 21 hours). It is possible that participants habituated to both positive and negative reinforcers across this time span and the reinforcing value of their contingent removal/presentation decreased considerably throughout the study. Because we did not evaluate whether habituation affected both reinforcers equally, it is possible that the reinforcing value of one reinforcer differed from the other in important ways by the end of the experiment. Future researchers may consider conducting baseline sessions using sounds that had not been equated for reinforcing value and then only introducing the target sounds during the actual parameter sensitivity assessments. This modification would decrease participant exposure to target sounds in a meaningful way, potentially decreasing the probability of participants habituating to the target sounds. Furthermore, future researchers could conduct a second PR reinforcer value assessment following parameter sensitivity assessments to determine the degree of habituation that occurred for each reinforcer.

A second limitation of this experiment was that participants were required to work on simple math problems throughout both parameter sensitivity assessments; except when they obtained reinforcement. If escape from completing simple math problems functioned as a reinforcer for a participant, it is possible that behavior came under the control of escape from work instead of escape from (or access to) sounds (as was intended). Future research in this area may address this concern by providing individuals with a low-effort escape response (that would provide subjects with escape from prompts to work for a certain period of time) that is concurrently available with target responses during experimental sessions. Thus, researchers could exclude data produced by participants who consistently opted to escape from prompts rather than work to produce target reinforcers during each experimental session.

Third, we did not systematically evaluate parameter sensitivity at different qualities of reinforcement. Instead, we prioritized controlling reinforcer quality across processes. We did this to ensure that observed differences across processes could not be attributed to differences in quality of reinforcement. However, in so doing it is possible that we selected low quality positive and negative reinforcers. If this were the case then it is possible that participant responding came under the control of extraneous consequences (like the one mentioned above). It is also possible that our participants' parameter sensitivities differed across the quality spectrum. If this were the case, our experiment could not have shown those differences. However, because we controlled for quality across processes, we have evidence that responding can be sensitive to different parameters of positive and negative reinforcement when quality is held constant.

Finally, although we attempted to control for differences in the idiosyncratic effects on behavior produced by topographically different stimuli by selecting positive and negative reinforcers from the same stimulus class (i.e., sound), it is possible that the differences observed in Lucy's experiment were a function of differences in the effect on behavior of the stimuli evaluated, not in the reinforcement processes. For example, it is possible that different sounds, with reinforcing values identical to the sounds presented to Lucy in her experiment, would produce different hierarchies of parameter sensitivity.

Notwithstanding this final limitation, it is interesting to note that some evidence exists indicating that an individual's relative sensitivity to manipulations of parameters of reinforcement involving one stimulus class is correlated to his/her relative sensitivity to manipulations of parameters of reinforcement involving other stimulus classes. For example, research on impulsivity commonly pits favorable dimensions of immediacy in direct competition with favorable dimensions of magnitude. In these studies, experimenters manipulate dimensions of each parameter until participant behavior reflects indifference for either option.

Experimenters interpret these "indifference points" as an indication that the value of the smaller sooner reward is relatively equal to the value of the larger later reward. Interestingly, the degree to which individuals "discount" reinforcers from one stimulus class (i.e., produce indifference points that reflect a preference for smaller sooner rewards over larger later ones) is correlated to the degree to which they discount reinforcers from other stimulus classes (Odum, 2011a). So much so that it has been suggested that the degree to which an individual discounts reinforcers is a quantifiable "trait" of an individual's personality (i.e., Odum, 2011a, 2011b).

Given what we know about the consistency of an individual's sensitivity to the interactions of immediacy and magnitude, it may be that an individual's sensitivity to other parameter interactions are just as consistent. Even still, more research on the matter is merited. Specifically, because we know that different classes of reinforcement can control certain responses, but not others, when reinforcement process is held constant (for example, see Hanley, Iwata, & McCord, 2003, for a review of the variety of responses maintained either by the contingent presentation of attention, or tangible items, but not both, in research on functional assessments of problem behavior), it is possible that different classes of reinforcement also evoke different sensitivities to parameter manipulations (when process and value is held constant). Thus, it may be important for future researchers to replicate and extend our procedures using positive and negative reinforcers of various stimulus classes (with similar reinforcing values). If individuals who demonstrate differences in parameter hierarchies across reinforcement processes do not demonstrate differences in parameter hierarchies across stimulus type (when process is held constant), we would have stronger evidence that the differences in said hierarchies were a function of reinforcement process and not of some idiosyncratic effect that specific stimuli might have on behavior.

In spite of the limitations listed above, this study contributes to the literature in a number of ways. First, we outlined a method for evaluating and equating the reinforcing value of positive and negative reinforcers. Additionally, we demonstrated that our participants' behavior was differentially sensitive to specific parameter manipulations in positive and negative parameter sensitivity assessments when sound was manipulated. Furthermore, we showed that, for some participants, manipulations of the parameters of negative reinforcement may affect behavior differently than identical manipulations of the parameters of positive reinforcement. Finally, we showed that, when given a choice to work in a positive or a negative reinforcement paradigm, all participants preferred to work in positive reinforcement paradigms.

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APPENDICES

Appendix A

Parameter Sensitivity Assessment Treatment Integrity Data Collection Sheet

Appendix A

Parameter Sensitivity Assessment Treatment Integrity Data Collection Sheet

Treatment Integrity
Sr+/Sr- Research

Date:	**Client:**
Session:	**Data Collector:**
Condition:	Primary or Rely

Reinforcer withheld at beginning of session	Yes	No
Session duration is 10 minutes (+/-5 s)	Yes	No
Card on opposite pile is removed following participant choice	Yes	No

LEFT		
Rate ___________ Magnitude ___________ Immediacy __________		
Therapist posts correct sign	Yes	No
Therapist programs correct schedule	Yes	No
Reinforcer is delivered (+/-3 s): Immediately *OR* After a 30 s delay	Yes	No
Reinforcer is removed after: 10 s access *OR* 30 s access	Yes	No

RIGHT		
Rate ___________ Magnitude ___________ Immediacy __________		
Therapist posts correct sign	Yes	No
Therapist programs correct schedule	Yes	No
Reinforcer is delivered (+/-3 s): Immediately *OR* After a 30 s delay	Yes	No
Reinforcer is removed after: 10 s access *OR* 30 s access	Yes	No

[Yes] / [Yes + No] x 100 = Treatment Integrity   ☐ / ☐ = ☐

Appendix B

Tables

Table 1

Parameter Sensitivity Assessment Conditions. Highlighted cells depict dimensions of parameters being evaluated during each assessment.

	Sessions																	
	1: R v M		2: M v R		3: R v M		4: D v R		5: R v D		6: D v R		7: M v D		8: D v M		9: M v D	
Parameters	Set 1	Set 1	Set 2	Set 1	Set 2	Set 2	Set 2	Set 1	Set 1	Set 2	Set 1	Set 1	Set 1	Set 2	Set 1	Set 2	Set 2	Set 2
Rate (R)	*High*	*Low*	*Low*	*High*	*High*	*Low*	*Low*	*High*	*High*	*Low*	*Low*	*High*	High	High	High	High	High	High
Magnitude (M)	*Low*	*High*	*High*	*Low*	*Low*	*High*	High	High	High	High	High	High	*High*	*Low*	*Low*	*High*	*High*	*Low*
Delay (D)	Imm	Imm	Imm	Imm	Imm	Imm	*Imm*	*Del*	*Del*	*Imm*	Imm	*Del*	*Del*	*Imm*	*Imm*	*Del*	*Del*	*Imm*

Table 2

Parameter Values for Each Test of the Parameter Sensitivity Assessment

		Condition					
		D vs. M		D vs. R		R vs. M	
		Delay	Mag	Delay	Rate	Rate	Mag
Parameter Values (s)	Delay to S^r	0	30	0	30	0	0
	Mag of S^r	10	30	30	30	10	30
	Rate of S^r (VI)	15	15	45	15	15	45
	Total s of S^r	*10*	*30*	*30*	*30*	*10*	*30*
	Time Elapsed	*25*	*75*	*75*	*75*	*25*	*75*
	Prop. of time in S^r	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**

Appendix C

Figures

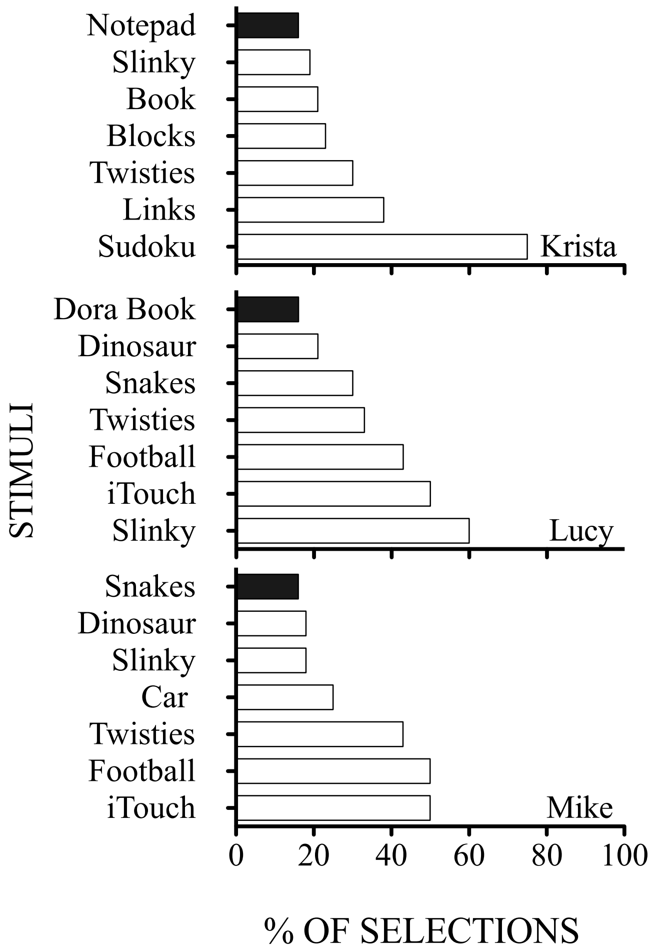

Figure 1: Results of each participant's MSWO preference assessment. The top panel shows Krista's data, the middle panel shows Lucy's, and the bottom panel shows Mike's. The x-axes show percentage of selections and the y-axes show the stimuli evaluated. Black bars represent the stimuli selected as low-preferred stimuli during subsequent PR reinforcer value assessments.

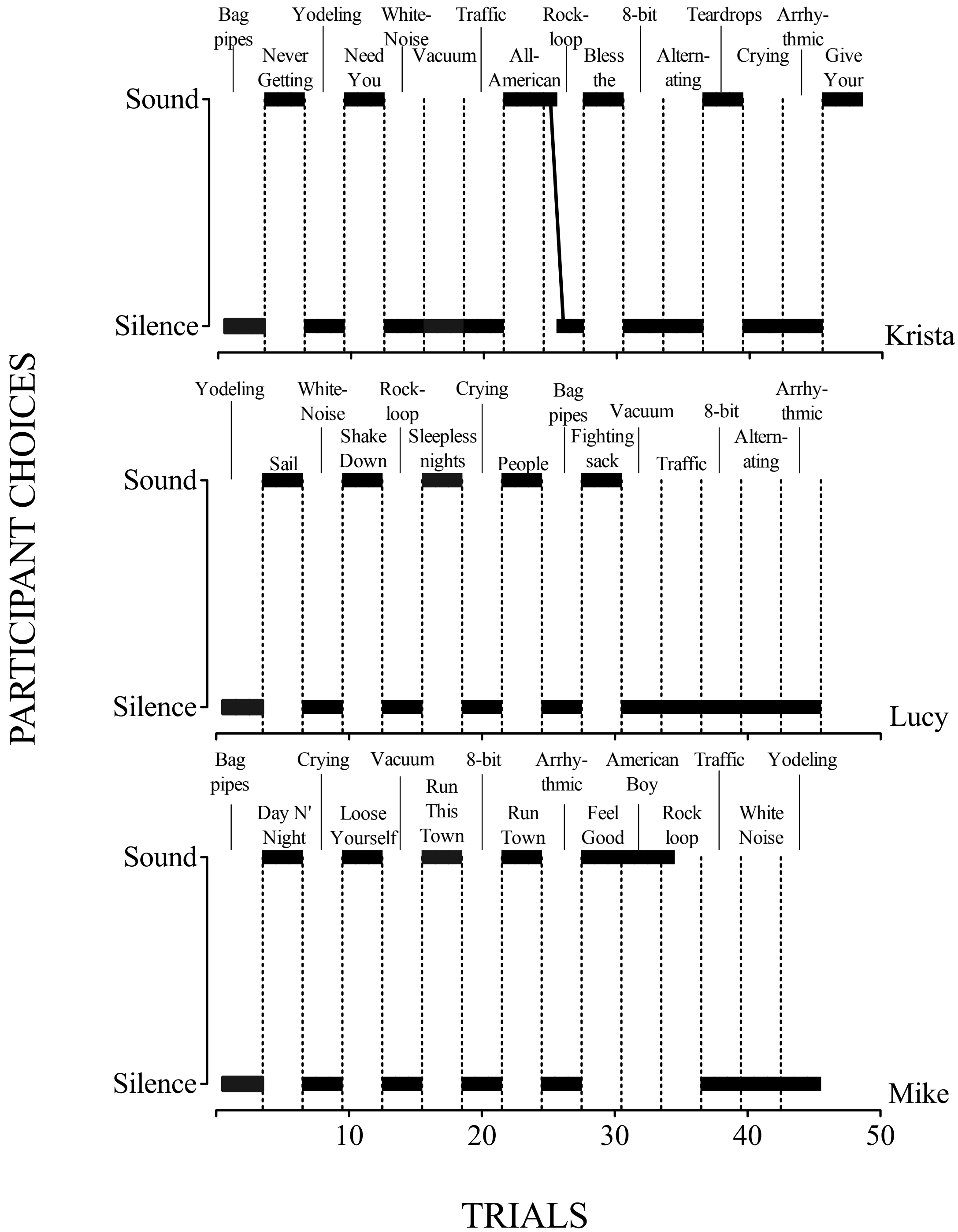

Figure 2: Results of preferred and aversive sound assessments. The top panel shows Krista’s data, the middle panel shows Lucy’s, and the bottom panel shows Mike’s. The x-axes show trials and the y-axes show participant choices.

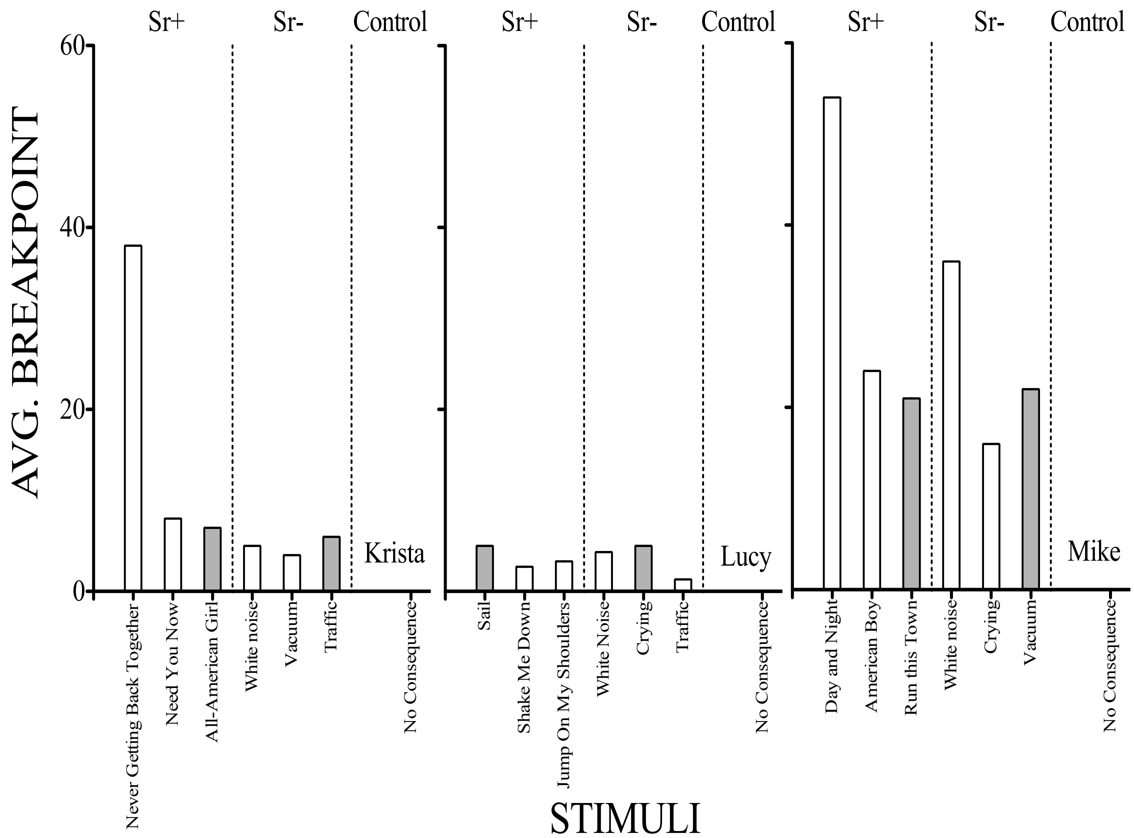

Figure 3: Results of the PR reinforcer value assessments. The left panel shows Krista's data, the middle panel shows Lucy's, and the right panel shows Mike's. The x-axes show the stimuli evaluated and the y-axes show average breakpoints produced by each stimulus. Bars highlighted in gray represent stimuli selected s positive and negative reinforcers during subsequent parameter sensitivity assessments.

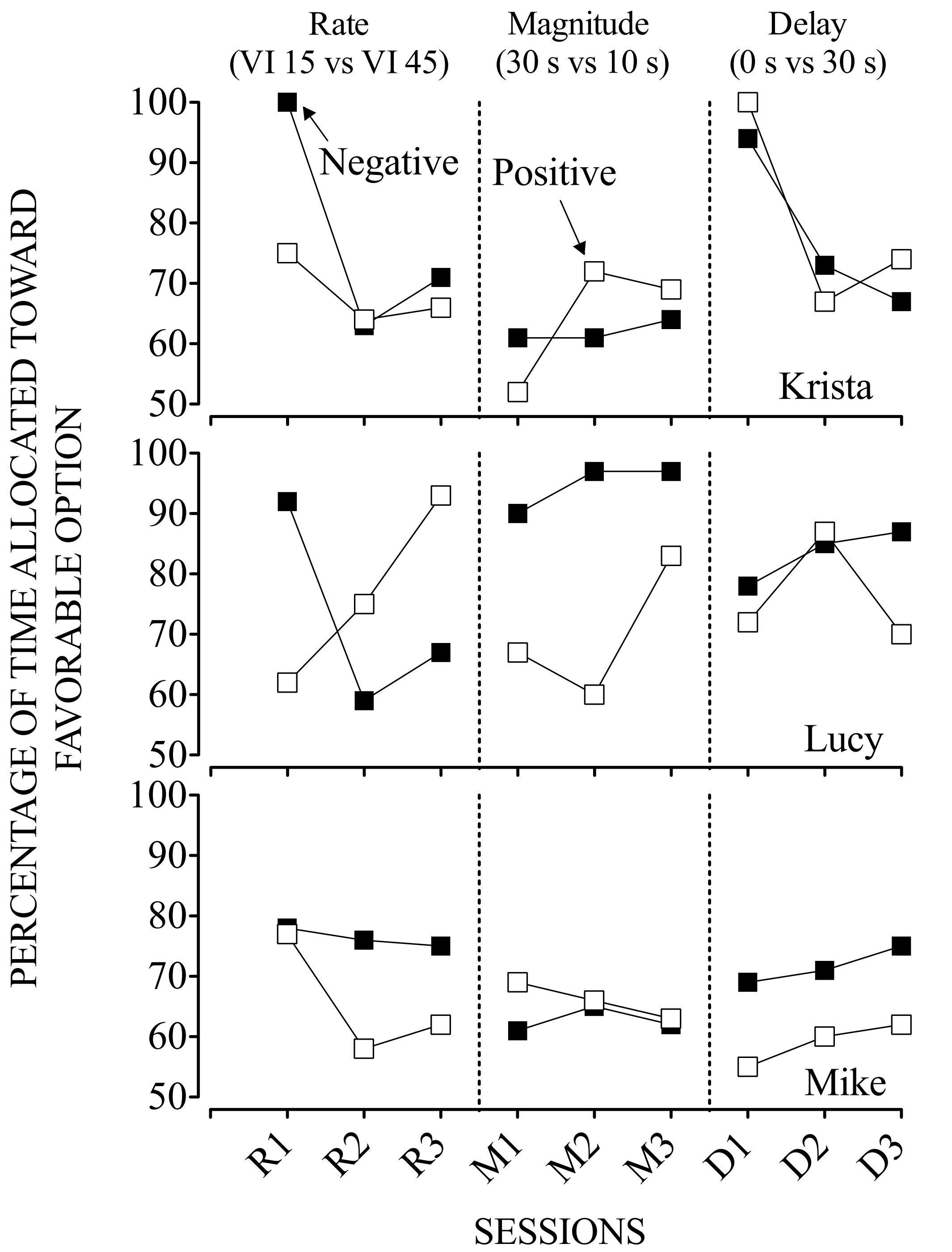

Figure 4: Final three sessions of baseline for positive and negative parameter sensitivity assessments. The x-axes show sessions and the y-axes show percentage of time allocated toward the option that produced favorable dimensions of each parameter of reinforcement. The top panel shows Krista's data, the middle panel shows Lucy's, and the bottom panel shows Mike's. Closed data points represent responding for negative reinforcement and open data points represent responding for positive reinforcement.

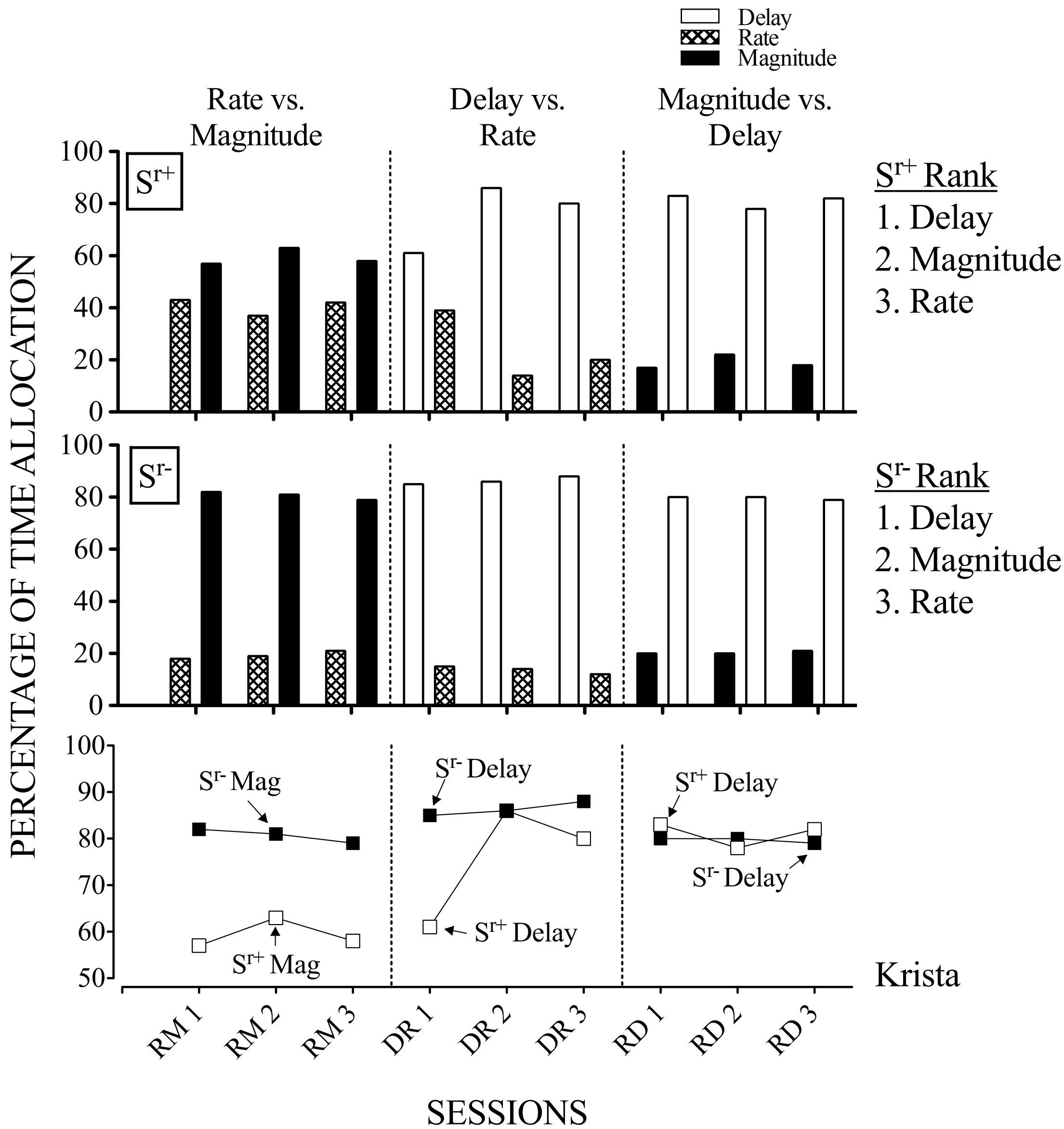

Figure 5: Results of Krista's parameter sensitivity assessment. The x-axes show sessions and the y-axes show percentage of time allocation. The top panel shows positive reinforcement. The middle panel shows negative reinforcement. The bottom panel compares responses allocated toward the preferable option in positive and negative assessments.

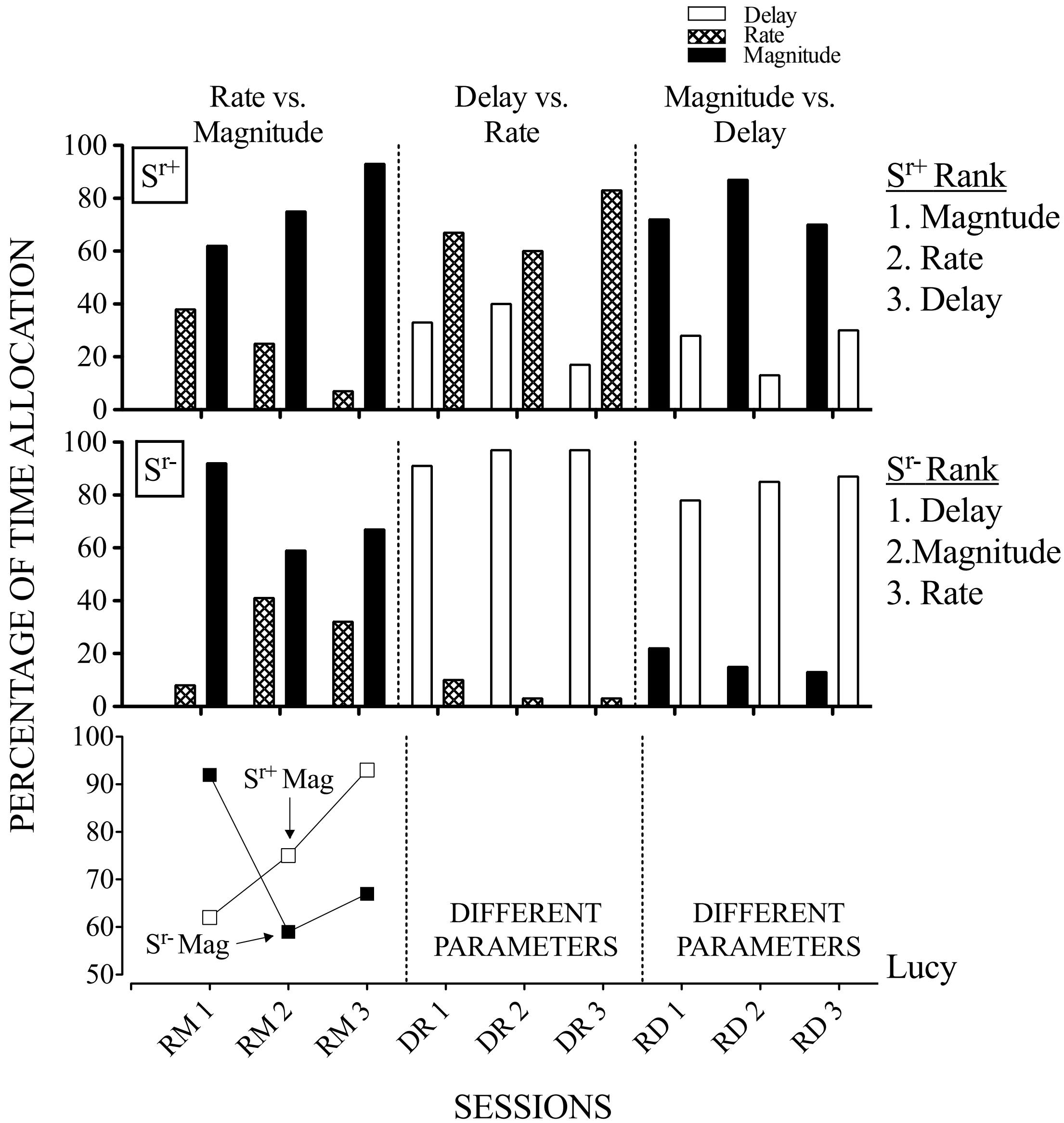

Figure 6: Results of Lucy's parameter sensitivity assessment. The x-axes show sessions and the y-axes show percentage of time allocation. The top panel shows positive reinforcement. The middle panel shows negative reinforcement. The bottom panel compares responses allocated toward the preferable option in positive and negative assessments.

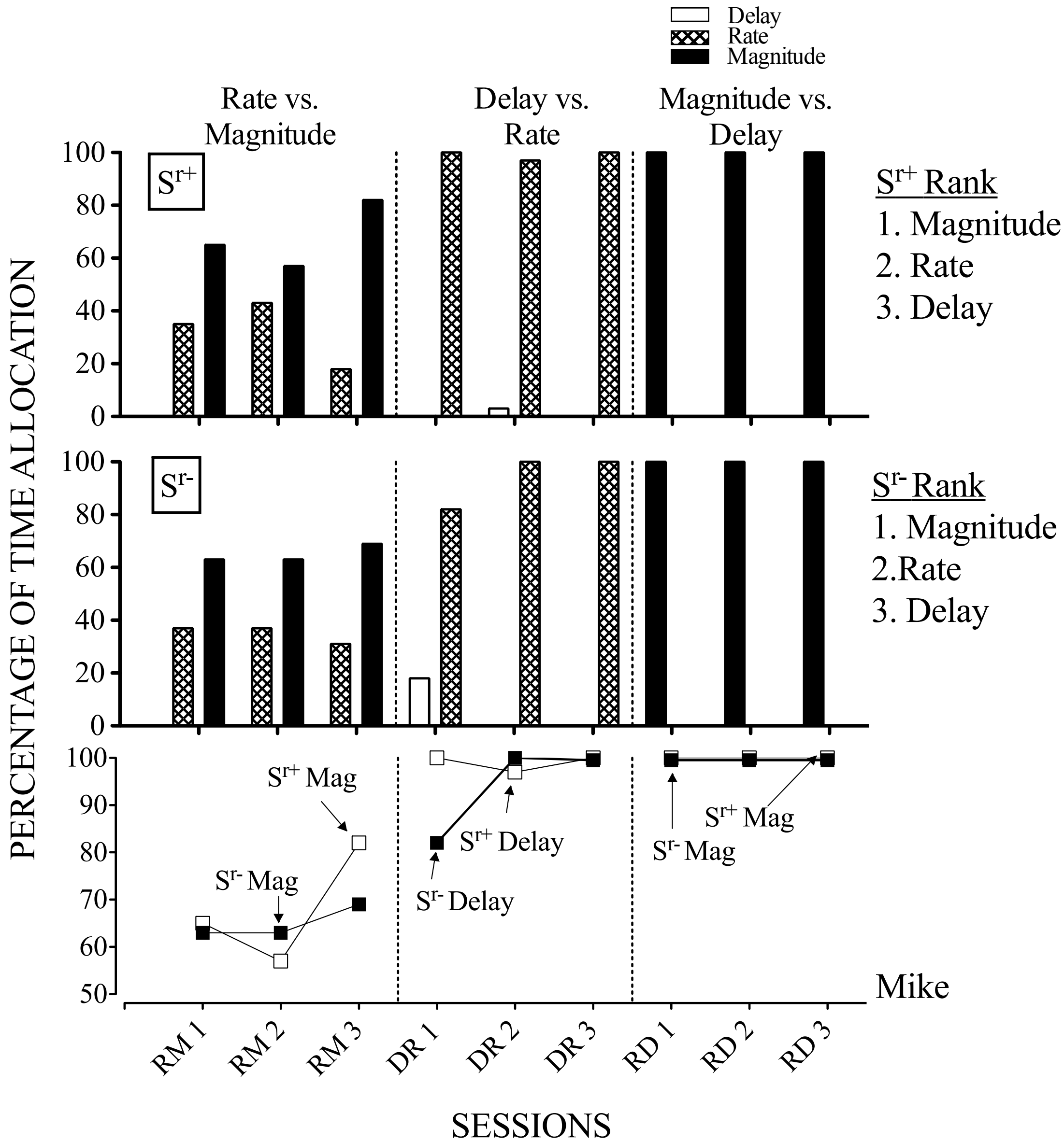

Figure 7: The results of Mike's parameter sensitivity assessment. The x-axes show sessions and the y-axes show percentage of time allocation. The top graph shows positive reinforcement. The middle graph shows negative reinforcement. The bottom graph compares responses allocated toward the preferable option in positive and negative assessments.

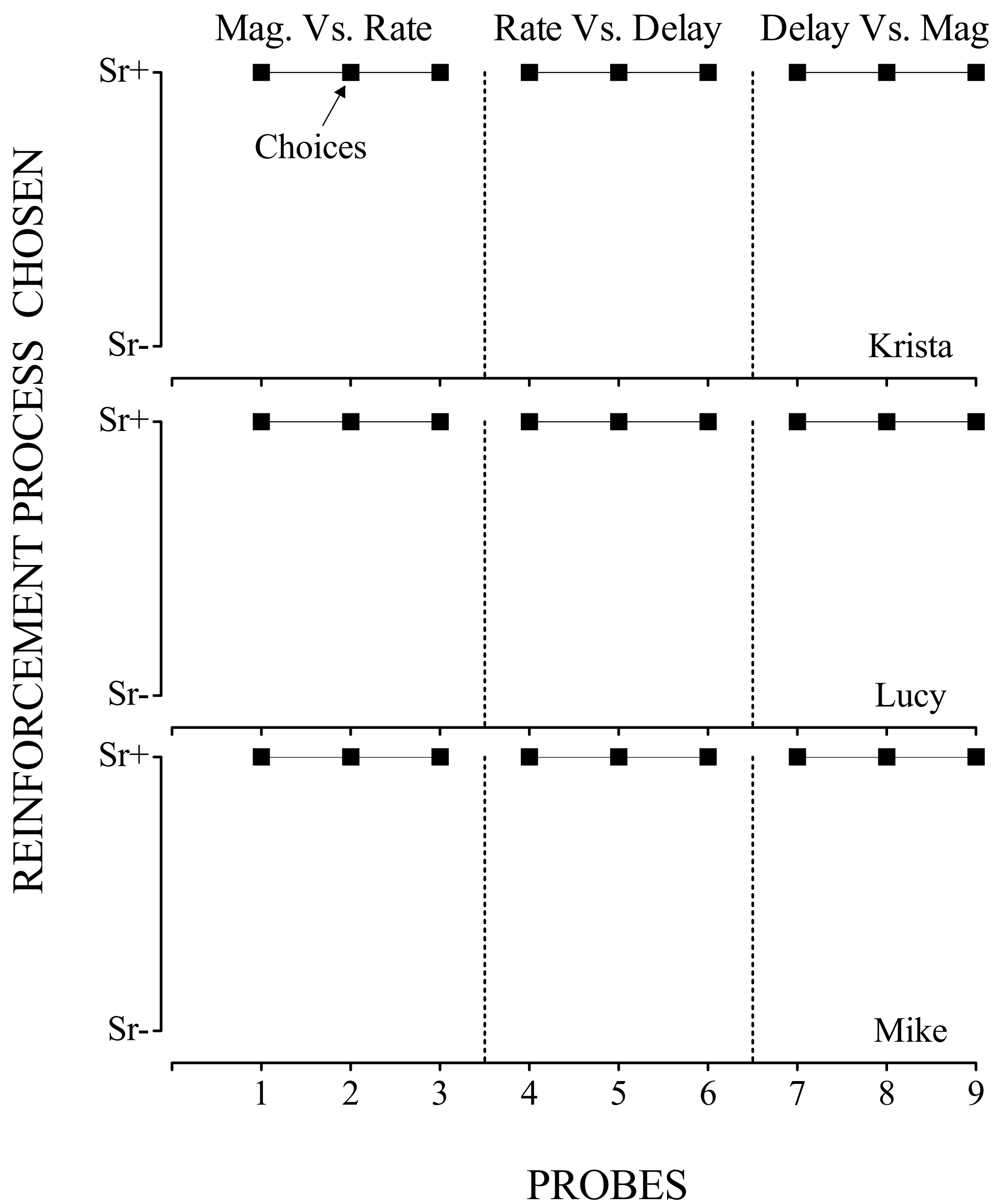

Figure 8: The results of the posttest preference probes. The top panel shows Krista's data, the middle panel shows Lucy's, and the bottom panel show's Mike's. The x-axes show probes and the y-axes show reinforcement processes.

CURRICULUM VITAE

July, 2013

Joseph Michael Lambert

Phone: 801-518-6527 / E-mail: Lambjoe189@gmail.com

EDUCATION

2009-2013	Ph.D.	Utah State University	Disability Disciplines *Concentration: Applied Behavior Analysis* Advisor: Dr. Sarah Bloom *Dissertation: Human sensitivity to manipulations of parameters of positive and negative sound reinforcement*
2007-2009	M.S.	Northeastern University	Applied Behavior Analysis Advisor: Dr. William Ahearn *Thesis: Assessing the effects of matched and unmatched stimuli on the persistence of stereotypy*
2000-2007	B.A.	Brigham Young University	Special Education *Concentration: mild/ moderate disabilities* *Minor: Teaching English To Speakers of Other Languages (TESOL)*

LANGUAGES

English
Portuguese
Spanish

LICENSES AND CERTIFICATIONS

2013-present — Board-Certified Behavior Analyst – Doctoral (Certification # 1-10-7022)

2010-2013 — Board-Certified Behavior Analyst

2007-2010 — Level 1 Mild/Moderate Special Education Teacher (PRAXIS II: Special Education–Mild/Moderate [K-12 license])

WORK EXPERIENCE

2013-present — Assistant Professor
Department of Special Education
Vanderbilt University
Nashville, Tennessee

2009-2013	Graduate Research Assistant/Therapist Severe Behavior Clinic Utah State University Logan, Utah
2010-2013	Behavioral Consultant Chrysalis Logan, Utah
2007-2009	Teacher The New England Center for Children Southborough, MA
2008-2009	Graduate Research Assistant The New England Center for Children Southborough, MA
2006-2007	Intern Centennial Middle School Provo, Utah
2006-2007	Assistant Wrestling Coach Provo High School Provo, Utah
2006-2008	Research Assistant Department of Social Work Brigham Young University
2005	Intern Care for Life Beira, Mozambique
2001-2002	Direct-Support Staff Rimland Services for Citizens with Autism Evanston, Illinois

GRANTS AND AWARDS

2013	Student Presenter Grant (Society for the Advancement of Behavior Analysis [SABA])
2013	Graduate Research Assistant of the Year (College of Education at Utah State University)
2011	FIPSE/Brazil Educational Opportunity Scholarship ($4,000)

(Utah State University)

2011 Student Grant Competition (travel, food, & lodging)
(Sao Paulo School for Advanced Sciences)

2011 Enhancement Award ($4,000)
(Graduate Student Senate at Utah State University)

COLLEGE TEACHING EXPERIENCE

2012 Instructor
Special Education 5050 (Applied Behavior Analysis 2: Applications)
Utah State University
Logan, Utah

2011 Teaching Assistant
Special Education 6700 (Introduction to Behavioral Research in Education)
Utah State University
Logan, Utah

2011 Teaching Assistant
Special Education 5050 (Applied Behavior Analysis 2: Applications)
Utah State University
Logan, Utah

2010 Teaching Assistant
Special Education 6750 (Supervised Practicum in Behavior Analysis)
Utah State University
Logan, Utah

2010 Guest Lecturer
Special Education 5050 (Applied Behavior Analysis 2: Applications)
Utah State University
Logan, Utah

SUPERVISION EXPERIENCE

2010-2013 Practicum Supervisor: Board-Certified Behavior Analyst Concentration, Special Education Masters Program
Utah State University
Logan, Utah

2010-2013 Undergraduate Student Supervisor (Severe Behavior Clinic)

Utah State University
Logan, Utah

2009-2013 Graduate Student Supervisor (Research & Severe Behavior Clinic)
Utah State University
Logan, Utah

MEMBERSHIPS

2013-present Association of Professional Behavior Analysts
2010-present Utah Association for Behavior Analysis
2009-present Association for Behavior Analysis International
2009-2010 Four Corners Association for Behavior Analysis
2005-2007 Council for Exceptional Children

EDITORIAL ACTIVITIES

Guest Reviewer (2013) *American Journal on Intellectual and Developmental Disabilities*
Guest Reviewer (2012) *Education and Treatment of Children*

SERVICE

2011-2012 Human Rights Committee Member
Chrysalis
Logan, Utah

2010-2011 Human Rights Committee Chair
Chrysalis
Logan, Utah

PEER-REVIEWED PUBLICATIONS – PUBLISHED OR ACCEPTED FOR PUBLICATION

Lambert, J.M., Bloom, S.E., Clay, C.J., Kunnavatana, S.S., & Collins, S.D. (accepted). Training residential staff and supervisors to conduct traditional functional analyses. *Research in Developmental Disabilities*

Sellers, T.P., Bloom, S.E., Samaha, A.L., Dayton, E., **Lambert, J.M.,** & Keyl-Austin, A.A., (2013). Evaluation of some components of choice making. *Journal of Applied Behavior Analysis, 42*, 455-464.

Bloom, S.E., **Lambert, J.M.,** Dayton, E., & Samaha, A.L., (2013) Teacher-conducted trial-based functional analysis as the basis for intervention. *Journal of Applied Behavior Analysis, 46,* 208-218.

Lambert, J.M., Bloom, S.E., Kunnavatana, S.S., Collins, S., Clay, C. (2013). Training residential staff to conduct trial-based functional analyses. *Journal of Applied Behavior Analysis, 46,* 293-300.

Lambert, J.M., Bloom, S.E., & Irvin, J. (2012). Trial-based functional analysis and functional communication training in an early childhood setting. *Journal of Applied Behavior Analysis*

Snyder, K., **Lambert**, J., & Twohig, M.P. (2011). Defusion: A behavior-analytic strategy for addressing private events. *Behavior Analysis in Practice, 4,* 4-13.

Roby, J.L., Lambert, M.J., **Lambert, J.M.** (2009). Barriers to girls' education in Mozambique at household and community levels: an exploratory study. *International Journal of Social Welfare, 18,* 342-353.

SUBMITTED FOR PUBLICATION

Lambert, J.M., Bloom, S.E., Dayton, E., Samaha, A.L., & Rodewald, A. (*submitted for publication*). Multiple mand training: reducing the effect of alternative response extinction on target response resurgence. *Journal of Applied Behavior Analysis.*

MANUSCRIPTS IN PREPARATION

Lambert, J.M., Bloom, S.E., Nickerson, C., Clay, C.J., & Samaha, A.L. (in preparation) Human sensitivity to manipulations of parameters of positive and negative reinforcement.

Lambert, J.M., Bloom, S.E., Dayton, E., Kunnavatana, S.S., & Samaha, A.L. (in preparation) The effects of noncontingent reinforcement on the persistence/resurgence of behavior: Applications of behavioral momentum theory.

Lambert, J.M., Bloom, S.E., Kunnavatana, S.S., Boyle, M., & Samaha, A.L. (in preparation). Evaluating correspondence between mand assessments and functional analyses of problem behavior.

Lambert, J.M., Bloom, S.E., Dayton, E., & Samaha, A.L. (in preparation). Assessment and treatment of behavior under control of escape from demands following removal of preferred materials.

TRAININGS AND WORKSHOPS

Bloom, S.E., Samaha, A.L., Lambert, J.M., & Hoffman, A. *Approaches to functional behavior assessment including trial-based FA.* Invited training presentation at the Carmen B. Pingree Center for Children with Autism, Salt Lake City, UT, 2013

Lambert, J.M. *An introduction to principles that govern behavior*. Special Education Dept., Preston Jr. High School, Preston, ID, August 2012

Bloom, S.E., Samaha, A.L., Kunnavatana, S.S., Lambert, J.M., & Clay, C.J. *Approaches to functional behavior assessment including trial-based FA.* Invited training presentation at the Utah Personnel Development Center, Salt Lake City, UT December 2011

Lambert, J.M., Kunnavatana, S.S., & Clay, C.J. *House manager training: Trial-based functional analysis.* Chrysalis group-homes in Cache County, Weber County, Salt Lake County, Utah County, Iron County, & Washington County, UT, October-November 2011

Lambert, J.M., Kunnavatana, S.S., Collins, S., Clay, C.J. *Supervisor training: functional analysis and trial-based functional analysis.* Invited training presentation at the Chrysalis Behavior Summit in Salt Lake City, UT, October 2011

Lambert, J.M. *An introduction to principles that govern behavior.* Bear River Activity and Skills Center, Logan, UT, June 2011

Bloom, S.E., Samaha, A.L., Kunnavatana, S.S., Lambert, J. M**.,** & Dayton, E. *Teacher-conducted trial-based functional analysis: A two-part professional development presentation*, Cache County School District, Logan, UT October 2010

Lambert, J.M. *An introduction to principles that govern behavior*. Special education dept., Oakwood Elementary School, Preston, ID, September 2010

CONFERENCE PRESENTATIONS

Lambert, J.M., Bloom, S.E., Samaha, A.L., Dayton, E., & Rodewald (2013 May). *Multiple mand training: a strategy for reducing the magnitude of the resurgence of problem behavior,* In K. Vargo, Chair, Strategies for Teaching and Maintaining Social Skills with Individuals with Developmental Disabilities. Symposium presented at the 39th annual convention of the Association for Behavior Analysis International, Minneapolis, MN.

Clay, C.J., Lambert, J.M., Bloom, S.E., & Collins, S.D. (2013, March). *Training residential staff and supervisors to conduct traditional and trial-based functional analyses*. In S. Bloom, Chair, Trial-Based Functional Analysis: Refinements and Extensions. Symposium presented at the 3rd annual convention of the Association of Professional Behavior Analysts, Las Vegas, NV.

Lambert, J.M. Bloom, S.E., & Irvin, J. (2013, March). *Trial-based functional analysis and functional communication training in an early childhood setting.* In S. Bloom, Chair, Trial-Based Functional Analysis: Refinements and Extensions. Symposium presented at the 3rd annual convention of the Association of Professional Behavior Analysts, Las Vegas, NV.

Lambert, J.M., Bloom, S.E., Samaha, A.L., Dayton, E., & Rodewald (2013 April). *Multiple mand training: a strategy for reducing the magnitude of the resurgence of problem behavior,* Intermountain Graduate Research Symposium, Logan, UT.

Lambert, J.M., Bloom, S.E., & Irvin, J. (2013 March). *Trial-based functional analysis and functional communication training in an early childhood setting.* In S. Bloom, Chair, Trial-Based Functional Analysis: Refinements and Extensions. Symposium presented at the 3rd annual convention of the Association of Professional Behavior Analysts, Las Vegas, NV.

Lambert, J.M., Bloom, S.E., Kunnavatana, S.S., Collins, S.D., & **Clay, C.J.** (2013 March). *Training residential staff and supervisors to conduct traditional and trial-based FAs.* In S. Bloom, Chair, Trial-Based Functional Analysis: Refinements and Extensions. Symposium presented at the 3rd annual convention of the Association of Professional Behavior Analysts, Las Vegas, NV.

Lambert, J.M., Bloom, S.E., Kunnavatana, S.S., Collins, S.D., & **Clay, C.J.** (2012 June). *Transitioning to functional analyses: An Organization-wide training.* In S. Bloom, Chair, Applying Behavior Analysis to Educational and Human Service Settings. Symposium presented at the 3rd annual meeting of the Utah Association for Behavior Analysis and Utah Conference on Effective Practices for Teachers and Human Service Professionals: Interventions Across the Lifespan, Logan, UT.

Lambert, J.M., Bloom, S.E., Dayton, E. Kunnavatana, S.S. & Samaha, A.L. (2012 June). *The effects of noncontingent reinforcement on the persistence/resurgence of behavior: Applications of behavioral momentum theory.* In S. Bloom, Chair, Applying Behavior Analysis to Educational and Human Service Settings. Symposium presented at the 3rd annual meeting of the Utah Association for Behavior Analysis and Utah Conference on Effective Practices for Teachers and Human Service Professionals: Interventions Across the Lifespan, Logan, UT.

Lambert, J.M., Bloom, S.E., Kunnavatana, S.S., Collins, S.D., & **Clay, C.J.** (2012 May). *Transitioning to functional analyses: An Organization-wide training.* In S. Collins, Chair, Staff Training in Community Residential Settings. Symposium presented at the 38th annual convention of the Association for Behavior Analysis International, Seattle, WA.

Lambert, J.M., Bloom, S.E., Dayton, E. Kunnavatana, S.S. & Samaha, A.L. (2012 May). *The effects of noncontingent reinforcement on the persistence/resurgence of behavior: Applications of behavioral momentum theory.* In S. Bloom, Chair, Evaluations of Interventions for Problem Behavior Using Contingent and Noncontingent Reinforcement. Symposium presented at the 38th annual convention of the Association for Behavior Analysis International, Seattle, WA.

Lambert, J.M., Bloom, S.E., Dayton, E. Kunnavatana, S.S., & Samaha, A.L. (2012 February). *The effects of non-contingent reinforcement on the persistence and resurgence of human behavior: Applications of behavioral momentum theory.* In T. Higbee, Chair, The Effects of Antecedent and Consequence Manipulations on Response Variability. Symposium presented at the 30th annual meeting of the Western Regional Conference on Behavior Analysis, California Association for Behavior Analysis, Garden Grove, CA.

Jensen, J., Bloom, S.E., & **Lambert, J.M.** (2011 June). *Assessment and treatment of problem behavior in an early childhood setting using trial-based functional analysis.* In. S.E. Bloom, Chair, Current research in trial-based functional analysis. Symposium presented at 2nd annual meeting of the Utah Association for Behavior Analysis/Utah Conference on Effective Practices for Teachers and Human Service Professionals: Interventions across the Lifespan/Utah Association for Behavior Analysis, Logan, UT.

Lambert, J.M. (2011 June). *The effects of using non-contingent reinforcement in the classroom: applications of behavioral momentum theory.* Training presented at the Utah Conference on Effective Practices for Teachers and Human Service Professionals, Logan, UT.

Jensen, J., Bloom, S.E., & **Lambert, J.M.** (2011 May). *Assessment and treatment of problem behavior in an early childhood setting using trial-based functional analysis*. In. A.L. Samaha, Chair, Factors Influencing Selection of Assessment and Treatment Development and Refinement of Assessment and Treatment Approaches for Individuals with Intellectual and Developmental Disabilities. Symposium presented at 37th annual meeting of the Association for Behavior Analysis International, Denver, CO.

Keyl-Austin, A.A., Bloom, S.E., Samaha, A.L., Lambert, J.M., & Boyle, M.A. (2011 May). *Effects of preference and stimulus variation on response persistence.* In. A.L. Samaha, Chair, Factors Influencing Selection of Assessment and Treatment Development and Refinement of Assessment and Treatment Approaches for Individuals with Intellectual and Developmental Disabilities. Symposium presented at 37th annual meeting of the Association for Behavior Analysis International, Denver, CO.

Lambert, J.M., Bloom, S.E., Dayton, E., Kunnavatana, S.S., Samaha, A.L. (2011 March). *Behavioral momentum: an analogue and applied study,* Intermountain Graduate Research Symposium, Logan, UT.

Sellers, T.P., Bloom, S.E., Samaha, A.L., Dayton, E., Lambert, J.M., Keyl-Austin, A.A. (2011 February). *Evaluating choice as a reinforcer.* In S. Bloom, Chair, Reinforcer Effectiveness: Choice, Predictability, and Price. Symposium presented at 29th annual meeting of the Western Regional Conference on Behavior Analysis, California Association for Behavior Analysis, Burlingame, CA.

Keyl-Austin, A.A., Bloom, S.E., Samaha, A.L., Lambert, J.M., & Boyle, M. (2011 February). *Effects of preference and stimulus variation on response persistence.* In S. Bloom, Chair, Reinforcer Effectiveness: Choice, Predictability, and Price. Symposium presented at 29th annual meeting of the Western Regional Conference on Behavior Analysis, California Association for Behavior Analysis, Burlingame, CA.

Lambert, J.M. (2010 June). *Designing and implementing functional communication training using signals*. Training presented at the Utah Conference on Effective Practices for Teachers and Human Service Professionals, Logan, UT.

Bloom, S.E., Lambert, J.M., Dayton, E., & Samaha, A.L. (2010 February). *Teacher conducted trial-based functional analysis as the basis for intervention.* In J. Hammond, Chair, Current Research in the Functional Analysis and Treatment of Problem Behavior. Symposium presented at 29th annual meeting of the Western Regional Conference on Behavior Analysis, California Association for Behavior Analysis, Burlingame, CA.

Bloom, S.E., **Lambert, J.M.,** Pollard, J.S., Sellers, T.P., Dayton, E., Samaha, A.L., & Keyl-Austin, A.A. (2010 March). *Evaluation of a teacher-conducted trial-based functional analysis.* In S.E. Bloom, Chair, Functional Assessment of Problem Behavior and Factors that Influence Effectiveness of Interventions. Symposium presented at 36th annual meeting of the Association for Behavior Analysis International, San Antonio, Texas.

Sellers, T.P., Bloom, S.E., Samaha, A.L., Dayton, E., Lambert, J.M., & Keyl-Austin, A.A. (2010 May). *Evaluating choice as a reinforcer.* In S.E. Bloom, Chair, Functional Assessment of Problem Behavior and Factors that Influence Effectiveness of Interventions. Symposium presented at 36th annual meeting of the Association for Behavior Analysis International, San Antonio, TX.

Sellers, T.P., Bloom, S.E., Dayton, E.D., Lambert, J.M., Austin, A.A., & Samaha, A.L., (2010 March). *Evaluating choice as a reinforcer,* Intermountain Graduate Research Symposium, Logan, UT.

Sellers, T.P., Bloom, S.E., Samaha, A.L., Dayton, E., Lambert, J.M., Keyl-Austin, A.A. (2010, February). *Evaluating choice as a reinforcer.* In S. Bloom, Chair, Reinforcer Effectiveness: Choice, Predictability, and Price. Symposium presented at 29th annual meeting of the Western Regional Conference on Behavior Analysis, California Association for Behavior Analysis, Burlingame, CA.

POSTER

Lambert, J.M., Bloom, S.E., & Jenson, J. (2011 January). *Assessment and treatment of problem behavior in an early childhood setting using trial-based functional analysis*. Poster presented at the São Paulo School for Advanced Science: Advances in Research and Treatment of Autistic Behavior international conference, Sao Carlos, SP, Brazil