To my Mom
ACKNOWLEDGMENTS

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Abstract of Thesis Presented to the Graduate School of the University of Florida in Partial Fulfillment of the Requirements for the Degree of Master of Science

THE MITIGATING EFFECTS OF REINFORCER MAGNITUDE AND QUALITY ON TREATMENT DEGRADATION: A TRANSLATIONAL APPROACH

By

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Differential reinforcement of alternative behavior (DRA) is an intervention for problem behavior in persons with neurodevelopmental disorders. DRA involves withholding the reinforcer for problem behavior while reinforcing an alternative response. Treatment integrity errors in DRA, including reinforcement of the target behavior (commission errors) or failure to reinforce the alternative response (omission errors), may be unavoidable in the natural environment and can degrade treatment effects. It is therefore important to investigate means to protect treatment effects against this degradation. An analogue preparation of DRA was devised with young learners with neurodevelopmental disorders to examine if enhanced reinforcer magnitude or quality for the alternative response could protect against treatment degradation as the proportion of errors increased. Across two experiments, reinforcer magnitude or quality was manipulated in favor of the alternative response in one condition but kept constant across both alternative and target behavior in a second condition. As errors increased, responding in both conditions was examined to determine the effect of these manipulations on subsequent behavior. Operating within the framework of behavioral momentum theory (BMT), it was hypothesized that manipulating parameters of
reinforcement to favor alternative behavior would make it more persistent in the face of greater errors. The results indicate that higher magnitude or higher quality reinforcement for alternative behavior may have some mitigating effects when treatment errors occur. Additionally, alternative behavior persisted in the higher conditions even when schedules of reinforcement favored target behavior. The results provide additional support for the utility of BMT in developing problem behavior interventions.
Neurodevelopmental Disorders

Neurodevelopmental disorders are defined as a broad group of neurobiological conditions manifesting early in development, and involve global or specific impairments in functioning, (Diagnostic and Statistical Manual of Mental Disorders, 5th ed.; DSM-5; American Psychiatric Association, 2013). Autism spectrum disorder (ASD) is a type of neurodevelopmental disorder characterized by persistent, pervasive deficits in social behaviors (e.g. difficulties engaging in reciprocal conversation), repetitive and restrictive interests or behavior (e.g. stereotypic motor behavior), the onset of which occurs in early childhood, and significantly impairs daily functioning (DSM-5; American Psychiatric Association, 2013).

Problem behavior in the form of aggression, self-injury, property destruction, etc., may often arise in the repertoires of individuals with neurodevelopmental disorders. Problem behaviors may vary in many ways across individuals, both topographically (e.g. intensity, frequency, and type of problem behavior), and functionally (Hanley, Iwata, & McCord, 2003). For example, aggression may occur because it has historically resulted in caregiver attention or escape from aversive activities or events. Problem behavior, if left untreated, may strengthen and maintain over time, severely inhibiting an individual from contacting reinforcement in their environment in appropriate ways, and further preventing them from acquiring the skills necessary to function effectively in social contexts. Problem behavior, how it arises, strengthens, and maintains, is directly affected by personal learning histories. Without understanding how these contingencies affect behavior, an endless number of interventions might be tested before finding one
that is effective; therefore, treatments designed to eliminate problem behavior should be based on understanding the functions underlying problem behavior specific to an individual (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994).

In applied behavior analysis (ABA), behavior analysts use evidence regarding the functional relations underlying an individual’s behavior to manipulate the environment towards producing socially significant behavior changes. Assessments are first developed to identify the functions of an individual’s problem behavior. Subsequent interventions, therefore, may be designed based on the environmental determinants of behavior.

**Interventions for Individuals with Problem Behavior**

Iwata et al. (1982/1994) developed a method that has become the hallmark of assessing the functional relations underlying problem behavior. The functional analysis (FA) of self-injury that they developed was an experimental process in which different antecedents and consequences were systematically manipulated across conditions to determine the contingencies maintaining the behavior. The FA eliminated the guesswork that comes from using non-experimental methods (such as caregiver report) to hypothesize the environmental determinants of behavior. The same general process has since been extended to assess other problem behaviors, such as aggression, property destruction, inappropriate vocalizations, PICA, etc. (Beavers, Iwata, & Lerman, 2013; Hanley et al., 2003).

Once the function maintaining problem behavior is known, a treatment plan can be developed. Treatments often involve extinction, reinforcement, or punishment procedures. Following the inception of FA methodology, using reinforcement-based procedures as at least one component of an intervention became more common than
using exclusively punishment-based procedures (Pelios, Morren, Tesch, & Axelrod, 1999).

One common reinforcement-based procedure used to treat problem behavior is differential reinforcement of alternative behavior (DRA). DRA is a multi-component treatment, in which problem behavior is placed on extinction, while an alternative, functionally equivalent response is strengthened through the reinforcement of that response. DRA has been shown to be relatively robust in the face of environmental disruptions or incorrect implementation of the treatment (St. Peter Pipkin, Vollmer, & Sloman, 2010; Vollmer, Roane, Ringdahl, & Marcus, 1999). However, some errors in the implementation of DRA may be unavoidable in the natural environment, and may still be detrimental to treatment effects if and when they occur (Vollmer, Sloman, & St. Peter Pipkin, 2008).

**Treatment Integrity**

Peterson, Homer, and Wonderlich (1982) defined treatment integrity as the extent to which the independent variable is implemented in accordance with the described procedures. Treatment integrity errors involve systematic deviations from these procedures. These errors may be difficult to avoid completely, especially with intervention packages involving multiple components like DRA. Treatment integrity errors during DRA may include omission errors, a failure to deliver a reinforcer following the occurrence of an appropriate behavior, and commission errors, in which a reinforcer is delivered following the occurrence of problem behavior.

**Treatment Degradation**

Several studies have been conducted to examine prevention of treatment degradation or reemergence of problem behavior following interventions. These
methods include serial training of additional alternative responses (e.g. Lambert, Bloom, Samaha, Dayton, & Rodewald, 2015), parent or teacher training to increase integrity at the outset of treatment (e.g. Sterling-Turner, Watson, Wildmon, Watkins, & Little, 2001), fixed-time noncontingent reinforcer delivery (e.g. Marsteller & St. Peter, 2014), and stimulus fading (e.g. Fisher, Thompson, Hagopian, Bowman & Krug, 2000). While these lines of research have investigated antecedent manipulations to maintain treatment effects in the face of disruptions, most methods have involved implementing programmed extinction as a test of how treatment effects maintain in the face of integrity errors. For example, Marsteller and St. Peter (2014) delivered reinforcers on a fixed-time (FT) schedule (i.e., a response-independent schedule) following DRA, and then implemented extinction of both problem behavior and the alternative behavior that was reinforced during DRA. The authors found that delivering reinforcers on an FT schedule following DRA mitigated levels of reemergence of problem behavior when all responding was exposed to extinction. These investigations are noteworthy in discovering antecedent manipulations that may be helpful in increasing response persistence when challenges to treatment effects occur. However, extinction of alternative behavior is only one type of integrity error that can occur during DRA. Therefore, it is important to study response patterns under various treatment integrity errors to determine how responding would change as a function of different types, and different levels, of treatment integrity errors.

**Treatment Integrity as the Independent Variable**

Multiple studies have examined the effects of treatment integrity errors on responding, focusing on both skill acquisition (e.g. Leon, Wilder, Majdalany, Myers, & Saini, 2014; Reed, Reed, Baez, & Maguire, 2011; Stephenson & Hanley, 2010; Wilder,
Atwell, & Wine, 2006) and problem behavior interventions (e.g. Athens & Vollmer, 2010; St. Peter Pipkin, Vollmer, & Sloman, 2010; Vollmer, Roane, Ringdahl, & Marcus, 1999). Leon et al. (2014) used a reversal design to measure the effects of varying levels of programmed omission and commission on compliance. In this context, errors of omission were defined as a failure to deliver reinforcement contingent on compliance. Errors of commission were defined as delivering reinforcement contingent on noncompliance. Types of errors were analyzed separately. The authors found that errors of commission were generally more detrimental to the occurrence of compliance than errors of omission, and that while a reversal to treatment implemented with perfect integrity mitigated future treatment degradation when errors of omission occurred, this was not the case when errors of commission were implemented. Wilder et al. (2006) examined the effects of varying levels of errors of omission in a three-step prompting treatment to increase compliance. The researchers found that errors of omission were fairly deleterious to treatment effects when three-step prompting was only implemented 50% of the time that noncompliance occurred. Idiosyncratic results have been found across studies regarding the relative effects of errors of omission versus errors of commission, but participants always perform at most effective levels when no integrity errors occur.

The effects of treatment integrity errors have also been examined in the context of treatment for problem behavior. Results of this line of research have varied. Vollmer, Roane, Ringdahl, and Marcus (1999) examined the effects of decreased treatment integrity in implementing DRA with individuals who engaged in problem behavior. Following baseline and DRA implemented with perfect integrity (i.e. every alternative
request was reinforced, while no problem behavior was reinforced), the authors varied
the probabilities of reinforcement delivered for problem behavior and alternative
behavior across varying schedules of reinforcement for alternative behavior and
problem behavior: 100/0, 75/25, 50/50, 25/75, and 0/100 for two subjects, and 100/0,
40/0, 20/0, and 0/100 for the third subject. These schedules denote the levels of global
treatment integrity within each phase. For example, in the 100/0 condition, 100% of
alternative behavior and 0% of problem behavior was reinforced. In the 75/25 condition,
75% of alternative responses were reinforced, and 25% of problem behavior responses
were reinforced. These were implemented using a variable-ratio (VR) schedule of
reinforcement, so in the 75/25 condition, 3 out of 4 alternative responses, on average,
would be reinforced, and 1 out of every 4 problem behavior responses, on average,
would be reinforced. Alternative behavior maintained across most conditions, even
when the schedules of reinforcement favored problem behavior. However, there was
some reduction in treatment efficacy at low levels of treatment integrity. The authors
concluded that DRA is a robust treatment of problem behavior that is generally resistant
to degradation in treatment integrity.

However, other research has shown that treatment integrity errors can be
deleterious to treatment effects. St. Peter Pipkin et al. (2010) analyzed the effects of
treatment integrity errors across three experiments. In Experiment 1, the authors
implemented omission, commission, and combined errors across 3 subsets of college-
aged individuals in a computerized analogue to DRA. In this computerized simulation,
two moving circles were each representative of one response: problem behavior or
alternative behavior. In the first phase, baseline, the circle representing problem
behavior, when clicked, delivered points to the participant. In the second phase, DRA, the circle representing problem behavior no longer accrued points when clicked, and the circle representing alternative behavior delivered points when clicked. Following DRA, the authors introduced varying levels of omission (subset 1), commission (subset 2), and combined errors (subset 3). In subset 4, the authors alternated phases of baseline, DRA, and 50% integrity errors. The authors found that errors of commission and combined errors led to the most degradation in alternative behavior responding when treatment integrity was low. In Experiment 2, an extension of subset 3, a child with off-task behavior was exposed to combined treatment integrity errors. Again, when treatment integrity was low, problem behavior reemerged to higher levels and alternative behavior decreased to low levels. Results of this research demonstrate the deleterious effects that low levels of treatment integrity can have on DRA. The authors also noted that combined errors may be what occur in the natural environment when treatment is generalized. This may hold important implications for future research analyzing treatment integrity errors.

**Manipulating Response and Reinforcer Parameters**

It may be important to consider what kinds of manipulations may increase the maintenance of higher rates of alternative behavior when treatment integrity errors do occur in the environment, to prevent the treatment from subsequently deteriorating. Such studies have examined variables that promote response allocation towards appropriate behavior, but not in a degradation context. Specifically, research in this area has included manipulating the response requirement by varying response effort (e.g. Horner & Day, 1991; Richman, Wacker, & Winborn, 2001), or analyzing changes to the
reinforcer by enhancing the magnitude, quality, or immediacy of reinforcement (e.g. Athens & Vollmer, 2010; Hoch, McComas, Johnson, Faranda, & Guenther, 2002).

Manipulation of reinforcement parameters in favor of one response has been shown to bias response allocation towards that response over another, when both are reinforced concurrently. Athens and Vollmer (2010) manipulated concurrent variable-interval (VI) schedules within a DRA-without-extinction arrangement to examine the effects of increased duration of reinforcement, quality of the reinforcer, and immediacy of reinforcer access in favor of alternative behavior on responding. All manipulations were somewhat effective in maintaining higher rates of alternative behavior, but problem behavior maintained at low to moderate levels. A higher quality reinforcer delivered contingent on alternative behavior was most effective, as well as when duration of access, quality of the reinforcer, and immediacy of reinforcement were combined to favor alternative behavior. Athens and Vollmer (2010) concluded that it takes a significant increase in reinforcer magnitude or quality contingent on the alternative response to decrease problem behavior to therapeutically appropriate levels. However, the researchers arbitrarily designated higher and lower quality reinforcers. Additionally, they noted that participants may have shown lack of sensitivity to VI schedules. Finally, because the authors did not program varying levels of reinforcement for both problem behavior and alternative behavior but rather kept the schedules of reinforcement for both responses equal and consistent, they could not evaluate the persistence of responding as schedules of reinforcement change (i.e. as treatment degrades).

Research has also examined the ways in which increasing the magnitude of a reinforcer may increase its relative efficacy. Trosclair-Lasserre, Lerman, Call, Addison,
and Kodak (2008) analyzed the relationship between preference for and efficacy of different magnitudes of reinforcement among individuals with problem behavior. The authors first conducted discrimination training between various magnitudes of access to each participant's functional reinforcers (e.g. 120 s of access as the high magnitude versus 10 s of access as the low magnitude). Then preference and reinforcer assessments were conducted to determine preference for and subsequent reinforcing efficacy of different magnitudes of reinforcement. The magnitude reinforcer assessment involved a progressive-ratio (PR) schedule of reinforcement with a terminal value of PR40. For three of four participants, both a preference for, and subsequent increase in responding was observed contingent on higher magnitude reinforcers. Additionally, responding was most significantly differentiated between magnitude values when the response requirement was highest. One participant failed to show preference for higher magnitudes and, subsequently, did not work more for higher magnitude items. The authors attribute this anomalous responding to satiation effects or a loss of potency of the initial reinforcer determined from her FA. Overall, the results of the study demonstrate that when larger magnitudes of reinforcers are preferred, they are likely to increase rates of responding in the face of leaner schedules of reinforcement relative to smaller magnitude reinforcers.

While the ability for researchers to bias response allocation when there are two or more alternatives available or to increase reinforcer efficacy by making manipulations to the reinforcing stimulus itself is likely helpful in designing treatments, prior research in this area does not account for what may happen when the reinforcement schedules for
all alternatives are systematically changed. Using BMT as a framework could suggest how these changes may affect responding.

**Behavioral Momentum Theory**

BMT may provide a useful framework under which to examine how to increase desirable behavior in the face of treatment integrity errors. BMT uses Newtonian physics as a metaphor. The theory proposes that there are two separable, converging forces on the strength of a discriminated operant: baseline rate of responding, and resistance of responding to change (Nevin and Grace, 2000).

The majority of BMT research has involved nonhuman animals as subjects, but in recent years there has been an increased focus towards conducting tests for resistance to change with human subjects, some regarding increasing the quality or magnitude of reinforcement contingent on a response and determining subsequent resistance to change of that response (e.g. Mace, Mauro, Boyajian, & Eckert, 1997; McComas, Hartman, & Jimenez, 2008). Results of this research may be useful when programming DRA procedures. While not yet investigated, selectively increasing magnitude and quality of reinforcement may subsequently increase the resistance of alternative responding when challenges in the form of treatment integrity errors occur.

Mace et al. (1997) conducted three experiments to elucidate the relationship between reinforcer quality and resistance to change in a behavioral momentum framework. In the first two experiments, the researchers examined the how different qualities of reinforcement would affect subsequent task completion. They reinforced high-probability tasks with either a higher quality reinforcer (food), or a lower quality reinforcer (praise), and tested persistence of task completion when low-probability tasks were introduced. In the final experiment the researchers implemented extinction tests
with rats using different qualities of food reinforcement. Overall, the authors found that higher reinforcer quality increased behavioral momentum, causing persistence on low-probability instructional tasks and on responses previously reinforced with higher quality reinforcers during an extinction test (Experiment 3).

Additionally, Milo, Mace, and Nevin (2010) analyzed resistance to change in responding maintained by constant versus varied reinforcers. Milo et al. (2010) first analyzed the response rates by subjects on switches associated with constant or varied reinforcement, and generally found that the subjects would respond more on the switch associated with varied reinforcement, suggesting the varied arrangement was higher quality. The authors then tested resistance to change by implementing work sessions followed by distraction tests. The authors found that responses reinforced with varied reinforcement were more resistant to distraction than responses reinforced with constant reinforcement. Together, these studies show that increasing reinforcer quality contingent on one response may result in greater resistance to change or disruption (increased momentum).

Proponents of BMT have postulated how some responses persist in the face of challenges by relating it to momentum. Manipulating certain reinforcer dimensions in favor of a response may increase the resistance of that response in the face of challenges in the form treatment integrity errors, as an intervention breaks down. Therefore, the purpose of this study was to investigate the role of reinforcer magnitude and quality manipulations on the prevention of treatment degradation when treatment integrity errors occur. These manipulations were analyzed in an analog arrangement to DRA, in which engaging in various object tasks (e.g. sorting silverware) was
representative of problem behavior and alternative behavior. Reinforcer magnitude and quality were manipulated in favor of alternative behavior in some conditions, and reinforcers were kept identical across problem and alternative behavior in other conditions. Following baseline and DRA, I parametrically increased combined omission and commission errors. I hypothesized that by increasing reinforcer magnitude and quality in favor of alternative behavior in some treatment conditions, alternative behavior would be more resistant to treatment challenges.
CHAPTER 2
METHODS

Subjects and Setting

Four individuals diagnosed with autism spectrum disorder participated in Experiment 1, and three of those four individuals participated in Experiment 2. All subjects were clients at a local clinic which provided behavior-analytic services to individuals with autism and related disabilities. The subjects were between 6 and 8 years of age, and ranged in vocal-verbal language abilities, but all had intact gross motor abilities and could comply with simple, one- to two-step prompts and instructions. Nigel was a 7-year-old boy who spoke in one- to two-word phrases. Amelia was an 8-year-old girl. Amelia was able to speak in complete sentences. Lee was a 6-year-old boy who was non-vocal but communicated using the Proloquo2Go™ application on a touch screen tablet. Dean was a 7-year-old boy who was mostly non-verbal and had only 1 or 2 signs in his repertoire, and engaged in echolalia. The parents or guardians of the subjects signed informed consent waivers prior to the onset of the study. In addition, all subjects were told that their work was voluntary and that they could stop responding at any time during any session.

Prior to recruitment into the study, participants were observed to ensure that they did not exhibit problem behavior that would interfere significantly with ongoing task instruction. It should be noted, however, that Dean began to exhibit problem behavior of an increasingly disruptive nature during instructional activities, both within and outside of the sessions, as his participation in Experiment 1 came to a close. Therefore, he did not complete Experiment 2, but instead was placed in a problem behavior assessment and treatment protocol.
All sessions were conducted in a separate room of the clinic in which the participants were receiving services. The rooms were approximately 3m x 2m (Nigel and Amelia), and 6m x 6m (Dean and Lee). Each session area within the rooms was equipped with a rectangular table, two chairs, tripod and camera, and response materials.

**Response Measurement**

Analog response tasks were selected to represent target behavior (i.e., problem behavior that would be the focus of an intervention in a clinical context) and alternative behavior in both experiments. All responses were non-resetting (e.g., dropping coins in a bucket, sorting silverware into bins) and resulted in discrete, permanent products that could be objectively defined and recorded. The responses for target and alternative behavior within an experiment for any given subject were identical, but the stimuli were differently colored (i.e. sorting blue coins in a blue bucket as an analog to target behavior, sorting red coins in a red bucket as an analog to alternative behavior). Table 2-1 displays the specific responses for each subject for each experiment.

Sorting coins in a bucket was defined as the subject placing one or more coins inside the bucket and releasing his or her hand from the coin. Sorting silverware in bins was defined identically to that of sorting coins inside buckets. Stuffing envelopes was defined as the subject placing one or more pieces of paper inside the envelope and releasing his or her hand for at least 1 s. For all responses, a 1-s onset/offset must have occurred between responses to be scored as separate occurrences. Additionally, moving the same coin, item of silverware, or piece of paper from one bucket, bin, or envelope to another (i.e. across response stimuli of both target and alternative behavior), or in and out of the same container was not scored as a separate response
unless the subject placed the item on the table and released his or her hand from the stimulus for at least 1 s, thereby “resetting” the response, before placing the item back into a container. If multiple items were placed in the container at once, or within the 1 s of a prior item, only one response was scored.

Reinforcement time was defined as any instance in which the subject was holding the edible item in his or her hands, and terminated once the edible item passed the plane of the mouth and was released from the subject’s hands. Reinforcement time was subtracted from total session time before calculating responses per minute (RPM). The purpose of this removal was due to the fact that holding the edible item prior to consumption often naturally interfered with engaging in a subsequent response.

Procedural fidelity was measure by collecting data on therapist delivery of reinforcement. Delivery of reinforcement was scored as any instance in which the therapist placed the edible reinforcer contingent on the specific response on a plate next to the stimuli, in front of the subject.

**Interobserver Agreement (IOA) and Procedural Fidelity**

Trained graduate students or undergraduate students served as data collectors. Data were collected on handheld smartphones using the Countee™ application. IOA was collected by having a second observer simultaneously and independently record dependent variables during a session. Data were collected on number of responses, therapist delivery of reinforcement, and duration of edible handling time. Agreement on responses was calculated by first dividing each session into 10-s consecutive intervals. For target behavior, alternative behavior, and therapist delivery of reinforcement, agreement was calculated between two observers by dividing the smaller frequency
recorded within an interval by the larger frequency recorded, creating an average across all intervals, and multiplying by 100%. Agreement on edible reinforcement time was calculated by counting the number of 10-s intervals in which observers agreed on the occurrence/non-occurrence of the behavior, dividing the number of intervals with an agreement by the total number of intervals, and multiplying by 100%.

In Experiment 1, IOA and procedural fidelity data were collected for 25.3%, 33.7%, 33%, and 22.7% of experimental sessions for Nigel, Amelia, Lee, and Dean, respectively. Mean agreement scores for Nigel were as follows: alternative behavior, 97.6% (range, 90% to 100%); target behavior, 96% (range, 86.7% to 100%); consumption time, 92.5% (range, 83.3% to 100%). Mean agreement scores for Amelia were as follows: alternative behavior, 95.4% (range, 73% to 100%); target behavior, 98.3% (range, 87.22% to 100%); consumption time, 95.6% (range, 87% to 100%). Mean agreement scores for Lee were as follows: alternative behavior, 97.1% (range, 82% to 100%); target behavior, 95.8% (range, 80% to 100%); consumption time, 91.9% (range, 73.3% to 100%). Mean agreement scores for Dean were as follows: alternative behavior, 91.9% (range, 70% to 100%); target behavior, 97.5% (range, 88% to 100%); consumption time, 96.4% (range, 87% to 100%).

Procedural fidelity scores for Nigel’s were as follows: edible delivery following alternative behavior, 98.2% (range, 85% to 100%); edible delivery following target behavior, 98.3% (range, 73.3% to 100%). Procedural fidelity scores for Amelia’s sessions were as follows: edible delivery following alternative behavior, 95.3% (range, 78% to 100%); edible delivery following target behavior, 98.1% (range, 78.3% to 100%). Procedural fidelity scores for Lee’s sessions were as follows: edible delivery following
alternative behavior, 95.3% (range, 70% to 100%); edible delivery following target behavior, 95.9% (range, 81.9% to 100%). Procedural fidelity scores for Dean’s sessions were as follows: edible delivery following alternative behavior, 92.8% (range, 82% to 100%); edible delivery following target behavior, 97.8% (range, 80.4% to 100%).

In Experiment 2, IOA and procedural fidelity data were collected for 35%, 24.2%, and 25% of experimental sessions for Nigel, Amelia, and Lee, respectively. Mean agreement scores for Nigel’s behaviors were as follows: alternative behavior, 96.3% (range, 81% to 100%); target behavior, 98.6% (range, 88.3% to 100%); consumption time, 96% (range, 83.3% to 100%). Mean agreement scores for Amelia’s behaviors were as follows: alternative behavior, 92.1% (range, 83.3% to 100%); target behavior, 96.9% (range, 83.3% to 100%); consumption time, 92.8% (range, 83.3% to 100%). Mean agreement scores for Lee’s behaviors were as follows: alternative behavior, 95.5% (range, 71.7% to 100%); target behavior, 97.1% (range, 90% to 100%); consumption time, 93.9% (range, 86.7% to 100%).

Procedural fidelity scores in Nigel’s sessions were as follows: edible delivery following alternative behavior, 97.6% (range, 86.7% to 100%); edible delivery following target behavior, 98.5% (range, 86.7% to 100%). Procedural fidelity scores for Amelia’s sessions were as follows: edible delivery following alternative behavior, 93.3% (range, 80% to 100%); edible delivery following target behavior, 98.3% (range, 88.3% to 100%). Procedural fidelity scores for Lee’s sessions were as follows: edible delivery following alternative behavior, 98.1% (range, 81.7% to 100%); edible delivery following target behavior, 97.5% (range, 83.3% to 100%).
Experiment 1- Magnitude

Pre-Assessments

Paired-stimulus preference assessment

We conducted a nine-item paired-stimulus preference assessment (PSPA; Fisher et al., 1992) to identify potential edible reinforcers for each participant. Prior to the assessment, a structured interview, modified from the Reinforcer Assessment for Individuals with Severe Disability (RAISD; Fisher, Piazza, Bowman, & Amari, 1996), was conducted with caregivers to determine preferred foods for each subject. If the parent listed more than nine items as preferred, and approximately equivalent number of salty, sweet, savory, and sour items were selected based on the report to equal nine items in total. Prior to the assessment, the subject was exposed to each edible in isolation to sample it. They were given 10 s to sample the food item. If an item was refused twice, that item would not be included in the array. While the subject was sampling the item, the therapist would name the item (e.g. “this is a gummy bear”). One participant (Lee) would not sample all of the items, and so a modified six-item PSPA was implemented.

A matrix was designed for the PSPA trials in which each edible item was to be compared against every other edible item two times. For the 9 item PSPA, there were a total of 72 trials (Appendix A), and for the 6 item PSPA, there were a total of 30 trials (Appendix B). As each presentation of item pairs occurred twice, the positioning of each item (i.e., to the left or the right side of the participant) was counterbalanced across the two trials. The PSPA was completed when all permutations of edible item pairs were tested twice.
In each trial, the therapist sat across from the participant and placed the edible items on two separate plates in front, and out of reach of, the participant. The therapist pointed to each item and stated what each item was (e.g. “this is a gummy bear, and this is a chocolate chip”). The therapist then slid the plates within reach of the participant, while stating “choose the one you want”. Data collectors recorded the item selected by the participant. The item not selected was immediately removed from the participant’s vicinity. If the participant did not consume the item following selection, it was logged in the assessment notes. If the participant did not choose an item within 5 s, the therapist delivered an additional verbal prompt of “choose the one you want”. If, after an additional 5 s, the participant still did not choose, the items were removed and a new trial began. The trials without a selection were marked on the data sheet, and at the end of the assessment, the therapist returned to those trials and reintroduced the items. If the participant still did not select an item, that trial was eliminated from calculation.

Percent selection for each item was calculated by dividing the number of times an item was selected by the number of times that item was available. That number was then multiplied by 100%. The resulting values created a hierarchy of preference among items. The highest-preferred edible item (i.e., the one selected most often) was then assessed in the stimulus magnitude preference assessment.

**Stimulus magnitude preference assessment**

Following the PSPA, a stimulus magnitude preference assessment was conducted with the most highly-preferred edible item determined from the PSPA. The purpose was to determine the point at which the subject discriminated a change in magnitude in the amount of the edible item. This assessment also ensured that the
participant preferred a greater amount of the edible item over a lesser amount. The arrangement of edible items in each trial looked identical to that of a PSPA. Each session consisted of five trials. However, trials differed from the PSPA in that selection was made between different amounts of the same edible item. In the first session, the edible amount used in the PSPA was placed on both plates. The purpose of the first session was to elucidate any side biases that may affect responding in later sessions. Following the first session, a second session was arranged with selections made between one piece of the edible item, and two pieces of the edible item. Therapists randomly counterbalanced arrangement of the edible amounts (to the left or to the right of the participant) across trials. Sessions continued in the following ascending values after one versus two: one versus three, one versus four, one versus five, one versus ten, one versus fifteen, one versus twenty. Following exclusive selection of the higher magnitude edible item across a session, the participant was exposed to the same magnitude values in an additional session to ensure that selection was again exclusive towards the higher magnitude amount. Contingent on exclusive selection of the higher magnitude edible item in the second session, the assessment was considered completed. For Amelia, the SMPA had to be modified because she continued to select the lower magnitude edible item amount. The therapist delivered a choice between one half of the initial edible item amount and the full edible item amount (i.e., a smaller piece of a chip than that which was delivered during the PSPA, versus the amount delivered during the PSPA). Following this modification, Amelia exclusively selected the larger edible piece across sessions, and the one half edible was used as the low magnitude amount while the full edible was used as the high magnitude amount.
Response probes

Following the edible preference assessments, response probes were conducted for analogue response tasks. The purpose of these probes was to ensure that responding on the task would not occur in the absence of reinforcement. Response probe sessions were 2 min in duration. The therapist placed the task materials in front of the participant and started a timer. Data on task engagement and task completion were collected using the Countee™ data collection application as duration measures, with immediate onset and offset criteria. Data collectors recorded task engagement if any part of the participant’s hands contacted any of the task materials. Data collectors also recorded task completion. As noted before, tasks were motor responses that resulted in a permanent product that could be discretely and objectively measured, and of which the subject has had no direct prior training or history of reinforcement.

Sessions were divided into 10-s intervals. If task completion occurred in 20% or fewer of the intervals in one session, and no responding occurred in a second consecutive session, that task would be used in the subsequent reinforcer assessment. If the subject did not achieve this criterion across 5 sessions, a new task would be probed.

Reinforcer assessment

Following successful completion of response probes, a reinforcer assessment was conducted. This assessment was implemented to test whether the low-magnitude amount determined from the SMPA would function as a reinforcer for the analogue task. Sessions were conducted in a free-operant arrangement, such that the participant was free to engage in the task for the entire time, some of the time, or none of the time. Sessions were a maximum of 5 min in duration, and terminated either following 5 min, following 3 occurrences of task completion, or following 1 min of no task completion.
The low magnitude amount of the edible items was delivered contingent on each task completion. A task would be moved to experiment proper once a participant completed the task 3 times per session across 2 consecutive sessions.

**General Session Arrangement**

Both response tasks were placed on either side of the participant, who was seated in the center of the table. The tasks were identical except for their color. One color was randomly assigned to be analogous target behavior, and the other, alternative behavior. The location of each task was counterbalanced quasi-randomly across pairs of sessions (equal and higher magnitude).

A brief forced exposure to the contingencies present for each response in each phase was implemented immediately prior to the beginning of the session: in a baseline forced exposure the participant received a low-magnitude edible item contingent on the target response, and nothing contingent on the alternative response, in a DRA forced exposure the participant received a low- or high-magnitude edible item (depending on the condition) contingent on the alternative response, and nothing contingent on the target response, and in all forced exposures for descending integrity phases, the participant received the low-magnitude edible item contingent on the target response, and a low- or high-magnitude edible item (depending on the condition) contingent on the alternative response. The participant was not directly instructed to engage in the task during the forced exposure, but rather was indirectly prompted by the therapist, who asked “what happens if you (named response task) on the (named one of the colored responses)?”. An example would be “what happens if you sort the coin in the blue bucket?”. Once the participant completed the response, the therapist delivered the consequence programmed for that response. Across all sessions, the edible item or
items contingent on each response were displayed on the table next to the response, but out of reach of the participant until they met the criteria to obtain the edible reinforcer.

The experiment was implemented using an alternating treatments design. The order of equal and higher conditions was alternated quasi-randomly across pairs of sessions, with the contingency that no condition be repeated more than twice in consecutive sessions. All sessions lasted 5 min.

**Equal magnitude condition**

In the equal magnitude condition, both target behavior and alternative behavior were reinforced with the low-magnitude edible item (the item amount delivered in the PSPA and reinforcer assessments).

**Higher magnitude condition**

In the higher magnitude condition, reinforcement delivered contingent on all alternative behavior was the high-magnitude reinforcer determined from the SMPA. Target behavior was reinforced with the low-magnitude reinforcer.

**Phase descriptions**

Baseline sessions mimicked a traditional baseline during a problem behavior intervention. During baseline sessions, target behavior was reinforced on a fixed-ratio 1 (FR1) schedule (i.e., every target response was reinforced), and there were no programmed consequences contingent on alternative behavior. This phase terminated when target behavior achieved stable rates, and alternative behavior remained at low or zero levels.

Following baseline, DRA was implemented. In DRA, the target response was placed on extinction (i.e., reinforcement was no longer delivered for target behavior),
and alternative behavior was reinforced on an FR1 schedule. The DRA phase ended when alternative behavior occurred at stable rates, and target behavior occurred at low or zero levels.

Following DRA, the descending treatment integrity phases were implemented. Treatment integrity was parametrically decreased by 20% across phases. These phases parametrically decreased until responding switched over across one or more conditions. Switching over was said to occur when mean rates of target behavior across a phase were higher than the mean rates of alternative behavior. In the 80% integrity phase, alternative behavior was reinforced on a VR 1.25 schedule. In other words, 4 out of every 5 alternative responses, on average, were reinforced. Target behavior was reinforced on a VR 5 schedule, in other words, 1 out of every 5 target responses, on average, was reinforced. In the 60% integrity phase, alternative behavior was reinforced on a VR 1.67 schedule, and target behavior was reinforced on a VR 2.5 schedule. In other words, 3 out of every 5 alternative responses, and 2 out of every 5 target responses were, on average, reinforced. In the 40% integrity phase, reinforcement schedules were the opposite of those in the 60% phase for target and alternative behavior, and in the 20% phase, reinforcement schedules were opposite of those in the 80% phase. If the participant continued to engage in higher mean rates of alternative behavior than target behavior in the 20% phase, a 0% integrity phase would be implemented. The contingencies of the 0% integrity phase were identical to those of baseline. The only difference between 0% integrity and baseline phases was the forced exposure prior to the start of the session. In the forced exposure trials prior to baseline, the subject received a low-magnitude edible item following completion of a target
response, and no edible following an alternative response. In forced exposure trials prior to the 0% integrity condition, the subject received a low-magnitude edible item following completion of a target response, and a low- or high-magnitude edible item (depending on the condition) contingent on completion of an alternative response even though no alternative responses would be reinforced during the session.

Following a phase in which responding switched over in one or both conditions (equal or higher), the descending integrity phases were terminated. This criterion was implemented for all participants except for Nigel in Experiment 1, who experienced an additional decreased integrity phase prior to the subsequent reversal phase. After terminating descending integrity phases, participants experienced a reversal to DRA. Once responding during the DRA reversal achieved stability, participants experienced a reversal to the integrity phase at which responding switched over. Once responding in the reversal phase stabilized, the experiment was complete.

**Experiment 2- Quality**

**Pre-Assessments**

**Paired-stimulus preference assessment**

A PSPA was conducted with identical procedures as those in Experiment 1. The edible item used in Experiment 1 was included in this PSPA. Edible items were loosely categorized as high-preference, moderate-preference, and low-preference categories: 85% or above constituted a high preference, 50%-85% constituted a moderate preference, and 50% or below constituted a low preference. These general categories of items were used to determine which items to assess in the subsequent progressive-ratio reinforcer assessment.
Response probes

Response probes were conducted identically to those in Experiment 1, but with new analogue response tasks.

Progressive-ratio reinforcer assessment

Following response probes, a progressive-ratio reinforcer assessment was implemented for each subject, using the analogue task chosen following successful completion of the response probe assessment. The function of this reinforcer assessment was to determine disparities in quality to use in experiment proper; to ensure the subject would work more for the high-quality reinforcer than the low-quality reinforcer (which was how “quality” was defined). The highest- and the lowest-preferred edible items from the PSPA were the first stimuli tested. Prior to each trial, the therapist conducted a forced-exposure to the contingencies so the subject came into contact with the edible item to be delivered contingent on task completion. Sessions were trial-based, and one trial consisted of completing the progressive-ratio (PR) requirement on the task, and subsequent reinforcer delivery. Sessions were terminated following completion of the terminal PR value (PR40) and delivery of the reinforcer, or following 2 min of no responding. The breakpoint of responding was defined as the last schedule value successfully completed. The PR schedule progressed as follows: PR1, PR2, PR3, PR 4 PR5, PR10, PR20, PR40. Sessions terminated after a completed PR40 trial if no prior breakpoint was reached. Sessions were conducted twice for each edible item assessed to ensure that responding was similar across sessions. Similarity, in this case, was defined as a change in breakpoint identical to, or no more than one PR value higher or lower than the first session. The edible item with the highest breakpoint was designated as the high-quality (HQ) edible item. The low-quality (LQ) item was selected.
as the item that had the lowest breakpoint above a PR4. This minimum schedule requirement was developed due to the reinforcement schedule values in experiment proper. In the 80% and the 20% phases, target behavior and alternative behavior, respectively, would be reinforced an average of 1 out of 5 times, and this minimum requirement would ensure that the LQ item would sustain a level of responding which had the capability to contact those contingencies. HQ items had to have a break point at least one PR value greater than the LQ item across all sessions conducted (e.g. HQ could have a break point of PR10 and LQ could have break point of PR5). If the highest- and lowest-preferred stimuli from the PSPA did not meet these criteria, other stimuli from the PSPA were assessed. If multiple edible items achieved the same break point, the HQ item was determined based on which was more preferred in the PSPA, and the LQ item was determined based on which was less preferred in the PSPA.

**Concurrent-choice reinforcer assessment**

A concurrent-choice reinforcer assessment was conducted following the PR reinforcer assessment. The purpose was to ensure that the participant engaged in the work task which produced the HQ reinforcer, when both HQ- and LQ-reinforced task responses were available. Sessions were up to 5 min in duration, and terminated following either 5 min, five consecutive or non-consecutive completions of the HQ- or LQ-reinforced task, or 1 min of no responding. The assessment terminated following two consecutive sessions of exclusive responding to the task that produced the HQ reinforcer, or following 3 sessions without meeting this criterion. If the participant did not allocate responding to the HQ-reinforced task, additional edible items were assessed in both the PR reinforcer and concurrent choice assessment until responding met criteria.
General Session Arrangement

Equal quality

Sessions were identical to those in the equal magnitude condition of Experiment 1; however, rather than the low-magnitude edible item being delivered contingent on both responses, the LQ item determined from the aforementioned reinforcer assessment was delivered contingent on both responses.

Higher quality

Sessions were identical to those in the higher magnitude condition of Experiment 1; however, rather than the high-magnitude edible item being delivered contingent on alternative behavior, and the low-magnitude edible item being delivered on target behavior, the HQ edible item was delivered contingent on alternative behavior while the LQ edible item was delivered contingent on target behavior.
Table 2-1. List of response targets used by each participant across both experiments.

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Nigel</th>
<th>Dean</th>
<th>Amelia</th>
<th>Lee</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Reinforcer magnitude</td>
<td>Sort coins in buckets</td>
<td>Sort silverware in bins</td>
<td>Sort coins in buckets</td>
<td>Sort silverware in bins</td>
</tr>
<tr>
<td>2: Reinforcer quality</td>
<td>Stuff envelopes</td>
<td>N/A</td>
<td>Stuff envelopes</td>
<td>Stuff envelopes</td>
</tr>
</tbody>
</table>
CHAPTER 3
RESULTS

Magnitude

Figure 3-1 shows the results of Experiment 1 for Nigel. The top panel shows sessions of the higher magnitude condition, and the bottom panel shows sessions of the equal magnitude condition. Again, the analysis was conducted in a multielement design, but to make visual comparisons easier, the conditions are separated into two graphs. Responding took time to stabilize in baseline across both conditions, but by the end of the phase, target behavior was occurring at steady rates, and alternative behavior was occurring at low or zero rates. In DRA, alternative responding increased to rates similar to those of target behavior in baseline, and target behavior decreased to low or zero rates. Upon introduction of the 80% integrity phase, target and alternative behavior increased in variability across both conditions. Responding continued to be variable across both equal and higher conditions at each treatment integrity value. In the 40% phase, alternative behavior occurred at higher overall rates in the higher condition, and was more variable in the equal condition. Target behavior, though variable in the 40% equal condition, occurred at higher mean rates overall than alternative behavior (Figure 3-8). As a reminder, we implemented a 20% phase for Nigel even though responding had switched over in the 40% phase of the equal condition, but for all other participants, we reversed to DRA following the phase in which responding switched over. In the beginning of the 20% phase in the equal magnitude condition, target behavior began to occur at higher rates than alternative behavior, but decreased and stabilized towards the end of the condition at moderate rates below that of alternative behavior. Overall, target behavior occurred at greater rates than that of alternative behavior across the
40% and 20% phases in the equal condition for Nigel, but alternative behavior persisted at higher rates than target behavior in the higher condition across all phases. Changes in responding occurred more quickly in the DRA reversal phase than in the initial DRA phase, with alternative behavior remaining at stable, moderate rates, and target behavior at low or zero rates across both conditions. Return to 40% integrity resulted in roughly equivalent response rates in the equal magnitude condition as those of the initial 40% phase.

Figure 3-2 shows the results of Experiment 1 for Dean. Similar to response patterns observed from Nigel, responding in baseline and DRA took several sessions to stabilize in both conditions. For Dean, alternative behavior remained at fairly steady rates in the higher magnitude condition, and while maintaining higher rates than target behavior, variability in responding increased across both the 80% and 60% integrity phases in comparison to DRA rates. Responding switched over in the equal condition at 60% integrity, but alternative responding remained dominant at that same value in the higher condition. Like Nigel, Dean engaged in high rates of alternative behavior, zero rates of target behavior in the DRA reversal phase. Additionally, Dean engaged in moderate to high rates of alternative behavior and low rates of target behavior in the 60% reversal phase in the higher condition, and higher rates of target behavior than alternative behavior in the equal condition.

Figure 3-3 shows the results of Experiment 1 for Lee. For Lee, responding took several sessions to stabilize in baseline, but for both subjects, target behavior occurred at steady rates, and alternative behavior at low or zero rates in the majority of baseline across both conditions. In DRA, alternative behavior occurred at moderate, steady
rates, with target behavior occurring at low to zero rates. Upon implementation of 80% integrity, Lee’s alternative behavior decreased in rates across both conditions, and in 60% and 40% integrity phases, both target and alternative behavior occurred at low and varying rates. Lee was the subject for whom responding was the least differentiated across conditions. In the 40% integrity phase across both equal and higher magnitude conditions, it appeared that Lee was engaging in patterned responding across both tasks, without specific adherence to the reinforcement schedules. It may be that Lee was more sensitive to errors of omission and commission, and less sensitive to changes in magnitude, and therefore switched responding across targets more rapidly than other participants did within both equal and higher magnitude conditions. While Lee’s allocation of behavior was similar across responses, he met the switch-over criteria in the 40% phase of the equal condition, in which the mean rate of target behavior across the phase was greater than that of alternative behavior. However similarly patterned the response rates both within and across conditions, Lee never met switch-over criteria in the higher magnitude condition (Figure 3-8).

Figure 3-4 shows the results for Amelia. Amelia was the subject for whom responding was most differentiated within conditions. Across both equal and higher magnitude conditions, alternative behavior maintained at high rates, and target behavior at near zero rates, for the majority of the descending integrity phases. Upon experiencing 20% treatment integrity, responding switched over in the equal condition, but alternative responding persisted at high rates in the higher magnitude condition.

**Quality**

Figure 3-5 shows the results of Experiment 2 for Nigel. The graphs are organized similarly to those of Experiment 1: the top panel shows sessions of the higher quality
condition, and the bottom panel shows sessions of the equal quality condition. Figure 3-6 shows the results for Lee, and Figure 3-7 shows the results for Amelia. For all three subjects, responding during baseline and DRA was stable, and alternative responding in the higher quality condition occurred at significantly higher rates than target behavior across all descending integrity phases. Nigel and Lee’s response patterns in the equal condition were slightly more variable than Amelia’s as treatment integrity continued to degrade. For both Nigel and Lee, target behavior began to occur at steady low rates across descending integrity phases. Because Nigel persisted in higher rates of alternative behavior in the equal condition through 20% integrity, a 0% integrity condition was implemented in which only target behavior was reinforced. Responding switched over in the equal condition at 0% integrity. However, although there was no reinforcement contingent on alternative behavior, alternative responding persisted in the higher quality condition at rates similar to those in the other descending integrity phases. For Lee, responding switched over at 40% integrity, while alternative behavior continued to occur at high and stable rates. For Amelia, target behavior occurred at near-zero rates across both conditions until responding switched over in the equal condition at 60% integrity. Responding switched over in the equal quality condition for all subjects while alternative behavior persisted at significantly higher rates than target behavior in the higher quality condition, even when treatment integrity levels were low.

**Summary**

Figure 3-8 shows the compiled mean rates of responding within each phase across conditions for both experiments one and two, plotted as a function of decreases in integrity values. For Nigel and Lee, rates of alternative behavior in the higher quality condition were greater overall than rates of alternative behavior in the higher magnitude
condition. Differentiation between target behavior and alternative behavior was also
greater in the equal quality condition compared to the equal magnitude condition. For
Amelia, responding occurred at similar rates across both experiments, though
responding switched over at a higher integrity value in the quality experiment than it did
in the magnitude experiment. Responding switched over in the equal quality condition at
a lower level of integrity than the equal magnitude condition for Nigel, and responding
switched over at equivalent levels of treatment integrity for Lee. For all subjects, across
both experiments, responding switched over in the equal quality and not in the higher
quality conditions.
Figure 3-1. Results of Experiment 1 for Nigel across both higher and equal conditions.
Figure 3-2. Results of Experiment 1 for Dean across both higher and equal conditions.
Figure 3-3. Results of Experiment 1 for Lee across both higher and equal conditions.
Figure 3-4. Results of Experiment 1 for Amelia across both higher and equal conditions.
Figure 3-5. Results of Experiment 2 for Nigel across both higher and equal conditions.
Figure 3-6. Results of Experiment 2 for Lee across both higher and equal conditions.
Figure 3-7. Results of Experiment 2 for Amelia across both higher and equal conditions.
Figure 3-8. Compiled mean rates of responding across Experiments 1 and 2 for Nigel (top), Amelia (second from top), Lee (third from top), and Dean (bottom).
CHAPTER 4
CONCLUSION

General Discussion

The occurrence of treatment integrity errors may be deleterious to treatment effects (St. Peter Pipkin et al., 2010). Effects of treatment integrity errors on problem behavior interventions have been examined by programming errors of omission, commission, or both, and examining subsequent responding (e.g. St. Peter Pipkin et al., 2010; Vollmer et al., 1999). Other areas of research have examined how to increase the persistence of a certain response by manipulating parameters of reinforcement contingent on that response (e.g. Hoch et al., 2002; Trosclair-Lasserre et al., 2008). The present study sought to extend these lines of research by examining the effects of reinforcer magnitude and reinforcer quality on responding in the face of treatment integrity errors during DRA, examining the resulting response patterns within the framework of BMT.

Reinforcer magnitude and quality were manipulated separately across two experiments. An increase in the magnitude or quality of the reinforcer was made available contingent on alternative behavior in one condition, while identical reinforcers were delivered contingent on alternative and target behavior in a second condition. By rapidly alternating both conditions in a multielement design, differences in responding across conditions could be elucidated.

Several general response trends were observed for all participants. Across both experiments, alternative behavior persisted in the face of lower treatment integrity values when reinforcer magnitude or reinforcer quality was higher contingent on alternative behavior than on target behavior. For the three participants who completed
both experiments, responding in the higher condition was more differentiated across descending integrity phases in Experiment 2 than in Experiment 1. There are several possible reasons as to why this occurred. First, the reinforcers used in Experiment 2 were topographically different. Perhaps, the use of a unique reinforcer contingent on alternative behavior in the higher quality condition was a more salient stimulus in aiding discrimination across the different conditions. Additionally, the higher-quality reinforcer was only available for one response (alternative behavior), in one condition (higher quality). In Experiment 1, the same reinforcer was delivered, albeit in different amounts, across all responses in both conditions. It may be that the scarcity of the higher-quality reinforcer further increased its reinforcing efficacy, and led to increased persistence of alternative behavior in Experiment 2 as compared to alternative behavior of Experiment 1. However, a sequence effect may have led to the differences in responding observed across experiments. Because all subjects experienced Experiment 1 prior to Experiment 2, response patterns in Experiment 2 could have been a product of this extra-experimental history.

While overall response trends were similar, individual differences across participants and across experiments were observed. In Experiment 1, responding in the 40% and 20% integrity reversal phases did not mimic the patterns of responding in the initial 40% and 20% integrity phase for both Nigel and Amelia, respectively, in the equal magnitude condition. In both cases, alternative behavior persisted at higher overall rates in the low integrity reversal phase than in the initial phase of the identical integrity value. The response patterns may perhaps be explained by a more recent exposure to DRA in the DRA reversal phase, in which alternative behavior was reinforced on an FR1
schedule, before immediately implementing the lower integrity reversal phase. In Experiment 2, this lack of reversal also occurred for Nigel and Amelia, but in the higher condition. For both Nigel and Amelia, target behavior emerged in the 0% and 60% reversal phase, respectively. However, target behavior occurred at significantly lower levels for both Nigel and Amelia in the initial 0% and 60% integrity phases, respectively. This increase in response variability may be explained by the abrupt and significant change from DRA to a lower value of treatment integrity, which perhaps aided in discrimination to the changes of the reinforcement schedule that occurred. However, this explanation is contradicted by the fact that the opposite phenomenon was seen to occur for both participants in the equal magnitude condition of Experiment 1. Perhaps the most parsimonious explanation is that extended exposure to the higher quality edible, and the experimental phases overall, led to some response variability in an attempt to maximize reinforcement of any kind whether it be the low or the high quality reinforcer.

The current experiments demonstrate the utility of BMT as a framework through which both predictions of and explanations for behavior may be made. In the context in which alternative behavior achieved a higher amount or quality of reinforcement, alternative responding was more resistant to challenges presented by diminishing reinforcement rates. Prior research has demonstrated that manipulating certain reinforcer parameters may increase behavioral persistence (Mace et al., 1997). The current study expanded upon past research by demonstrating that manipulating reinforcer magnitude and quality in favor of one response modified the stimulus-reinforcer relationships exclusive to that context, and therefore led to persistence of
alternative behavior in the higher conditions. That these differences were observed between conditions for all participants emphasize both the utility and the reliability of BMT as a framework capable of explaining general behavior patterns in the context of stimulus-reinforcer relations. These conclusions hold important implications for the usefulness of BMT as a guide for researchers and clinicians alike in developing research and interventions focused on the prevention of treatment degradation in the face of challenges by using this theoretical framework.

Magnitude Considerations

For all participants in Experiment 1, responding only switched over in the equal magnitude condition; alternative behavior persisted at higher rates than target behavior, in the face of low integrity levels, in the higher magnitude condition. It is worth noting that all participants met criteria for the stimulus magnitude preference assessment when the reinforcer magnitude was doubled (i.e., one versus two; for Amelia, it was one-half of the item amount delivered in the PSPA versus the full amount). Therefore, reinforcement was doubled in favor of the alternative response in the higher magnitude condition. Because reinforcement can be maximized in variable-ratio schedules by allocating exclusively towards one response, lawful responding in the equal condition would involve exclusive responding towards alternative behavior across 80% and 60% integrity, and exclusive responding towards target behavior in 40% integrity and below. However, in the higher magnitude condition, overall reinforcer intake is doubled for alternative behavior. Therefore, in the 80% integrity phase of the higher magnitude condition, when 8 out of 10 responses, on average, are reinforced, 16 reinforcers are, on average, delivered.
Using a molar account of behavior to examine total reinforcer gain, lawful responding in the higher magnitude condition would involve exclusive allocation towards the alternative behavior through 40% integrity, because 4 out of 10 responses reinforced, on average, would lead to an average of 8 reinforcers delivered per 10 responses. This is a greater overall number of reinforcers delivered than the average of 6 delivered per 10 responses contingent on target behavior in the 40% integrity phase. Exclusive engagement in target behavior would not be favored until 20% integrity in the higher magnitude condition for these participants. However, for all participants, we did not see these patterns of responding. There was general persistence of alternative behavior across both conditions, and alternative behavior continued to occur at higher rates in the equal magnitude condition beyond 60% integrity for all participants but Dean, for whom responding switched over at 60% integrity. For Nigel and Amelia, alternative behavior persisted in the higher magnitude condition in the 20% integrity phase, the phase in which more reinforcers would be earned overall by engaging in target behavior. However, the molar account of net reinforcer gain for alternative behavior across phases currently discussed may still, to some extent, explain why alternative behavior persisted in the higher magnitude condition. By adding more reinforcement contingent on alternative behavior in the higher magnitude condition relative to the equal magnitude condition, the stimulus-reinforcer relationships established in each condition were different. Alternative behavior persisted in the face of changes to the response-reinforcer relationships in the higher magnitude condition rather than the equal magnitude condition due to the stimulus-reinforcer relationships.
established in the higher magnitude condition, in which more reinforcement was available for alternative behavior.

**Limitations and Future Directions**

There are several limitations worth noting. First, the generality of these experiments are limited, as they were translational arrangements modeling a clinical intervention of problem behavior and treatment integrity errors of that intervention. Translational experiments, while important as bridge studies used to conduct experiments in highly controlled environments, do not account for an extended and uncontrolled history of reinforcement for problem behavior. General response patterns may occur in a clinical context in ways that were not observed using an analogue arrangement as an approximation to DRA. Future directions of this research should extend the translational arrangement conducted in the current experiment to problem behavior exhibited by individuals with disabilities to verify if the results obtained from this experiment are replicable in a clinical environment.

Additionally, sessions were conducted in controlled laboratory conditions and monotonic decreases in treatment integrity were implemented. While this monotonic decrease in treatment integrity was deliberate, as it allowed for the comparison of responding across equal and higher conditions as treatment integrity values were reduced, this likely does not represent how and when treatment integrity errors occur in the natural environment.

The brief and controlled phases of baseline and DRA do not account for the variety of ways in which problem behavior is acquired, reinforced, and maintained in the natural environment. Additionally, gradual decreases in treatment integrity is only one way in which errors may occur over time in the natural environment. For example, a
client may move from obtaining treatment in a controlled clinic with a therapist delivering
treatment 1-on-1 to a home environment in which the parent is trained to implement
treatment. Abrupt treatment integrity failures may initially occur, or persist at steady
lowered rates of integrity, due to competing environmental contingencies or protocol
complexity. Future research may involve changing the parametric sequence to
ascending rather than descending levels of integrity, or varying the treatment integrity
values more randomly. Changing the sequence or values of treatment integrity errors
implemented may affect responding differently (St. Peter Pipkin et al., 2010).

Implementing monotonic decreases in treatment integrity may have also led to
sequence effects. As the integrity errors were implemented on the same decreasing
trend for all participants, the effects seen could have been a function of gradually
shifting schedules of reinforcement but cannot be concluded as such. Tolerance to the
fading schedules of reinforcement across both responses may also have occurred.
Future research should further investigate the possibility of sequence effects by varying
the reinforcement schedules randomly rather than sequentially.

Reinforcers remained the same throughout each experiment. Varying the type of
reinforcer available may have helped control for changes in responding that would be
due to preference changes and satiation over time. In the present study, it was
important to keep the reinforcers the same because differences in quality and
magnitude may be idiosyncratic to each reinforcer. However, if the reinforcers had been
varied, perhaps response patterns across the experiments may have differed. Future
directions should attempt to examine how these differences may affect responding
under parametric schedules of treatment integrity errors. Additionally, a progressive-
ratio reinforcer assessment was only conducted in Experiment 2, as a means of identifying discrepancies in quality across reinforcing stimuli. As discussed, responding was more differentiated in Experiment 2 than in Experiment 1 across the decreasing treatment integrity phases. Perhaps, the reinforcing efficacy of the higher quality reinforcer was greater than that of the higher magnitude reinforcer for some, or all participants. If this was the case, it may explain the increased differentiation between rates of target and alternative behavior in Experiment 2. However, this could not be determined using the current methods. Future research may involve conducting progressive-ratio assessments for all reinforcers so that disparities in quality, if any, may be determined between the higher magnitude and the higher quality reinforcers.
APPENDIX A
9-ITEM PSPA DATA SHEET

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Session Number: ___________   Primary/Reliability

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Selection Summary:
(calculate the percent chosen for each item by dividing the number of trials the item was chosen/the number of times the item was presented x 100%)

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APPENDIX B
6-ITEM PSPA DATA SHEET

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Session Number: __________

Primary/Reliability

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Selection Summary:
(calculate the percent chosen for each item by dividing the number of trials the item was chosen/the number of times the item was presented x 100%)

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LIST OF REFERENCES


BIOGRAPHICAL SKETCH

Sarah’s major was psychology, with a focus in behavior analysis. She graduated with a Master of Science degree in the fall of 2018.