EFFECTS OF MATCHED REINFORCEMENT ON CORRECT RESPONDING
AND DISRUPTIVE BEHAVIOR DURING ACADEMIC INSTRUCTION

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An Abstract of the Dissertation Presented
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The effects of low and high quality reinforcement (LQ/HQ) and low and high effort tasks (LE/HE) on correct responding and disruptive behavior were evaluated using a sequential multiple schedule design (Wacker, McMahon, Steege, Berg, Sasso, and Melloy, 1990) during isolated instructional opportunities in experiment 1 and sequenced opportunities in experiment 2. Participants included 2 males and 1 female between 6-10 years of age with a diagnosis of Autistic Disorder. Results suggest that reinforcer quality and response effort differentially affected rate of correct responding and occurrences of disruptive behavior across participants. Implications for the use of prescriptive reinforcement in applied settings are discussed.
Acknowledgements

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Figure 6.2. Mean percentage disruptive behavior across experiment 2 conditions for Peter, Mary, and Paul.
Establishing or strengthening response-reinforcement relationships for desirable, socially meaningful responding is a principal interest in applied work. Accurately identifying and utilizing stimuli that function as reinforcers to support behavior change is thus a critical aspect of this process. The contingent use of preferred stimuli demonstrated to increase the occurrence of target responding relative to non-preferred and baseline conditions has been studied extensively (e.g. Pace, Ivancic, Edwards, Iwata, & Page, 1985; Fisher, Piazza, Bowman, Hagopian, Owens, & Slevin, 1992; Windsor, Piché, & Locke, 1994; DeLeon & Iwata, 1996). However, reinforcer efficacy parameters considering preference stability over time (e.g. DeLeon, Fisher, Rodriguez-Catter, Maglieri, Herman, & Marhefka, 2001; Hanley, Iwata, & Roscoe, 2006; Graff & Libby, 1999; Mason, McGee, Farmer-Dougan, & Risley, 1989), across different presentation methods (e.g. Northup, George, Jones, Broussard, & Vollmer, 1996; Roane, Vollmer, Ringdahl, & Marcus, 1998; Cohen-Almeida, Graff, & Ahearn, 2000; Conyers, Doole, Vause, Harapiak, Yu, & Martin, 2002; Kodak, Fisher, Kelley, & Kisamore, 2009), and relevant establishing operations (e.g. Vollmer, & Iwata, 1991; McGill 1999; Gottschalk, Libby, & Graff, 2000; Kodak, Lerman, & Call, 2007) have been investigated increasingly only recently.

Pace, et al., (1985), provided a method for the assessment of stimulus preference and reinforcer value for individuals living with profound disabilities. Fisher, et al. (1992), extended Pace, et al.’s (1985) contributions to the preference assessment literature by describing a procedure in which differentiated preference hierarchies could be more readily assessed for individuals living with severe and profound disabilities using a concurrent operants paradigm that more closely approximates naturally occurring
opportunities. Items frequently selected when paired with a variety of alternatives were attributed with having a higher value (Fisher, et al., 1992). DeLeon and Iwata (1996) extended the literature further by comparing the paired-stimulus (PS) (Fisher, et al., 1992), with the more time efficient multiple stimulus with replacement (MSW) (Windsor, et al., 1994), and multiple stimulus without replacement (MSWO) preference assessment methods. The most consistent rankings and differentiated preference hierarchies across administrations were produced during PS and MSWO assessments for individuals living with profound developmental disabilities (DeLeon & Iwata 1996).

As choice and preference are closely related it is necessary to also discuss the contributions of Herrnstein (1970) and Baum (1974). Herrnstein (1970) recognized the effect of multiple sources of reinforcement on relative rates of responding in the Matching Law. The Matching Law predicts that the relative response rate across two or more alternatives will match relative obtained rates of reinforcement for those alternatives and that differences in response allocation can be related to the quality of reinforcement or other varied dimensions effecting reinforcer effectiveness, such as varied response effort (Herrnstein, 1961, 1970). Baum (1974) expanded this theory to include a wider range of variables affecting choice in the Generalized Matching Law. Because choice is asymmetrical in most human environments, it is paramount to recognize the effect that dimensions of reinforcement such as delay, quality, and amount, as well as response effort may have on response allocation.

Several authors have since built upon the preference and choice-making literature bases established in the 1970’s, 80’s, and 90’s. An initial extension of the preference literature included assessing whether or not items identified as preferred in fact
functioned as reinforcers. Pace, et al. (1985), evaluated the effects of providing stimuli identified as preferred and non-preferred contingent on target responding. Overall, stimuli identified as preferred increased target responding relative to baseline and non-preferred conditions. One participant, however, demonstrated desired changes in target responding during the non-preferred condition. Thus raising questions about preferred item-reinforcer correspondence, the effects of familiarity and context on reinforcer efficacy, and social mediation as a possible confounding variable of reinforcement (Pace, et al., 1985).

Mason, McGee, Farmer-Dougan, & Risley (1989), evaluated the effects of a reinforcer assessment package utilizing the Pace, et al. (1985) method at the beginning and end of a study as well as daily pre-session mini-assessments for items identified as preferred in the more comprehensive initial single stimulus condition on correct responding, out of seat behavior, and individually defined maladaptive behaviors. Results support extensive evidence that providing preferred items contingent on target responding increased correct and decreased maladaptive responding. As well, results suggest that item preference is variable and subject to change across time and contexts (Mason, et al., 1989). Frequent mini assessments prior to teaching sessions, while not sufficient to replace more time consuming and detailed preference assessments, were thus recommended to promote timely responsiveness to dynamic shifts in student preference during instructional opportunities (Mason, et al., 1989). These results support those of Egel (1981) suggesting that providing the same items consistently may result in decreased correct responding and task engagement over time.
DeLeon and Iwata (1996) also evaluated reinforcer effects when items identified in preference assessments were delivered contingently on target responding. Results suggested that the MSWO and PS preference assessment methods more readily identified lower preferred items that also effectively functioned as reinforcers thus expanding the variety of items likely to support desired behavior change when delivered contingently. Roscoe, Iwata, and Kahng (1999) found similar results when assessing reinforcer efficacy for High-Preference (HP) and Low-Preference (LP) items identified during single and paired stimuli preference assessments. HP stimuli included items selected during both assessment methods 75% or more of trials, whereas, LP stimuli included items selected 100% of trials during single stimuli but only 25% or fewer of trials during paired stimuli presentations (Roscoe, et al., 1999). Although participants consistently demonstrated preference for HP items when provided within a concurrent arrangement, response rates also increased when LP items were provided in a single-schedule condition, suggesting that concurrent and single-schedule arrangements both provide important information regarding relative and absolute reinforcement effects and that LP items can be used to support desired responding while increasing reinforcer item variability (Roscoe, et al., 1999).

Consistent with Mason, et al. (1989) and Roscoe, et al. (1999) recent research indicates that item variability can be an important dimension of reinforcer efficacy. However, frequent assessments of preference can be time consuming and logistically difficult to perform in applied settings. Evaluating the effectiveness of time efficient methods that can readily and accurately identify effective reinforcers is therefore advantageous for applied settings.
DeLeon, et al., (2001) initially used the lengthier paired-stimulus (PS) (Fisher, et al., 1992) preference assessment method to identify a hierarchy of preferred items for 5 individuals with developmental disabilities. During subsequent sessions, experimenters used “brief” single presentation MSWO assessments prior to work sessions to determine a preference hierarchy for the same items in the PS assessment. If an item identified as the most highly preferred during daily brief MSWO sessions differed from the top ranked item identified using the more lengthy PS assessment, experimenters presented a concurrent-operant reinforcer assessment to determine the “relative strength” of the different items (DeLeon, et al., 2001).

Results indicated that daily MSWO sessions frequently identified items that were different from the top ranked PS items, and that responding during reinforcer assessments was frequently allocated to tasks associated with the delivery of the highest ranked item identified during single presentation MSWO assessments (DeLeon, et al., 2001). These results suggest that preference is not necessarily stable across days, and that preferences can change both within and across sessions rapidly. Thus, while not sufficient to replace more lengthy and detailed preference assessment methods such as the PS method, reducing the time and effort associated with conducting preference assessments may increase the frequency with which preference assessments are conducted and thus enhance the reinforcing effects of selected stimuli.

As was previously discussed, regarding the Matching Law, it is imperative to understand how different dimensions of reinforcement such as rate, quality, magnitude, and immediacy effect desired responding and disruptive behavior. As well, it is necessary to understand the effects on desired and undesired responding that response dimensions,
such as effort can have. The effect that increased response effort, in the form of quantity of responses or the force or magnitude of a response required prior to the delivery of reinforcement, has on reinforcer strength has been the subject of several investigations (e.g. Neef, Mace, Shea, & Shade, 1992; Neef, Shade & Miller, 1994; Roane, Lerman, & Vorndran 2001; DeLeon, Frank, Gregory, & Allman, 2009; Penrod, Wallace & Dyer, 2008; Glover, Roane, Kadey, & Grow, 2008).

Several authors have demonstrated that increasing the effort required to emit the disruptive response can be an effective intervention for decreasing some disruptive behaviors (e.g. Irvin, Thompson, Turner, & Williams, 1998; Piazza, Roane, Keeney, Boney, & Abt, 2002; Zhou, Goff, & Iwata, 2000). As well, decreasing response effort can be an important intervention component for increasing desired responding such as emitting mands during functional communication training (e.g. Richman, Wacker, & Winborn, 2001), and completing math worksheets (e.g. Lannie & Martens, 2004), or arithmetic problems (e.g. Mace, Neef, Shade, & Mauro, 1996).

Neef, et al., (1992) evaluated the effects of equal and unequal reinforcer quality (program money vs. nickels) and rate of reinforcement (Variable Interval (VI) 30-s vs. VI 120-s) on time allocation across 2 concurrently available sets of math problems in an applied demonstration of the Matching Law. Sensitivity to the different VI schedules was only observed after the introduction of countdown timers signaling the reinforcement intervals. Once the timers were introduced, results indicated that time allocation closely matched relative rates of obtained reinforcement given the same quality of reinforcement. However, responding shifted to the leaner schedule when this schedule was associated with the higher quality item (nickel). The leaner schedule can be conceptualized as an
increased response effort condition as the amount of time required to pass prior to the introduction of a preferred stimulus was larger in the VI-120-s than in the VI 30-s condition. Thus this shift in responding towards the higher quality stimuli in the higher effort condition suggests that high quality items were more resistant to increases in schedule requirements.

Neef, et al., (1994), specifically examined the separate effects that alterations in the reinforcer dimensions of rate, quality, and delay, as well as response effort had on the allocation of responding for 6 youths. Students were provided with two concurrent sets of math problems correlated with different colors that were equal across two dimensions and unequal across another two. Neef, et al., (1994), found that responding across varied response/reinforcer dimensions was differentially allocated across students.

Roane, et al., (2001), evaluated participant responding under increasing progressive ratio schedule requirements. The authors used Fisher et al.’s (1992) PS preference assessment method to identify 2 highly preferred items. Reinforcer efficacy of each item was determined by providing items for 20-seconds contingent on the completion of a progressively increased number of responses (i.e. button press) in a single-operant arrangement. Results demonstrated that for all participants, 1 of the 2 stimuli was associated with a greater resistance to increased schedule requirements. Overall, these results suggest that while 2 stimuli may be similarly effective as reinforcers for low effort tasks/schedule requirements, the same items may be differentially effective as reinforcers for high effort tasks/schedule requirements. The authors additionally evaluated the effects of high and low preference items when delivered with differential reinforcement interventions for disruptive behavior. Results
suggested that the high-preference stimuli were more likely than lower preferred items to reduce problem behavior (Roane, et al., 2001).

In a related behavioral economics case study, Tustin (1994) equally varied schedule requirements for 2 preferred stimuli between FR 1 and FR 20. Results indicated that participant preference for 1 of the 2 concurrently available preferred stimuli reversed when schedule requirements increased (concurrent FR 10). DeLeon, Iwata, Goh, and Worsdell (1997) also examined the effects of increasing schedule requirements on preference for items that were either similar or dissimilar across sensory modalities. The authors exposed participants to 2 different panels that when pressed produced 2 different stimuli. The number of panel presses required prior to the introduction of a stimulus was originally FR 1 for both panels. However, once responding stabilized, the ratio requirements were increased progressively to FR 2, 5, 10, for similar and dissimilar items and to FR 20 for dissimilar items only. Results indicated that when the stimuli were dissimilar (i.e. food vs. leisure item) no clear preference was observed for FR 1, 2, 5, 10, and 20 schedules, however, when the stimuli were similar (i.e. food vs. food) clear preference for one item emerged as schedule requirements were increased from FR1 to 5 or 10. These results support and extend Tustin (1994), indicating that for similar items preference for one item may be apparent when schedule requirements are high but not when low.

DeLeon, et al. (2009) assessed progressive-ratio breaking points during various tasks for four individuals living with developmental disabilities to examine the correspondence between preference assessment results and the value of stimuli assessed via a progressive-ratio schedule. Results suggest that stimuli identified during paired-
choice preference assessments as highly preferred were associated with higher breakpoints under a progressive-ratio schedule than less preferred items, indicating that a higher amount of work or higher breaking point threshold was associated with higher stimulus values for contingently delivered items (DeLeon, et al., 2009).

Shore, Iwata, DeLeon, Kahng, and Smith (1997), examined the interactive effects of preferred items identified to effectively substitute for self-injurious behavior (SIB) that appeared to be maintained by automatic reinforcement. The authors found that participants almost exclusively allocated responding to object manipulation when object manipulation and SIB were concurrently available. The response effort required to engage in object manipulation was systematically modified by anchoring the object at different lengths in front of the participant, while the response effort required to engage in SIB remained constant. The authors found that small increases in object manipulation response effort shifted responding towards SIB.

Gwinn, Derby, Fisher, Kurtz, Fahs, Augustine, and McLaughlin (2005), examined the effects of both varied response effort and reinforcer delay on task engagement and aberrant behavior. The authors used Fisher et al.’s (1992) PS procedure to determine a hierarchy of preferred stimuli. A reinforcer assessment was then conducted to assess reinforcer quality, similarly to Piazza, Fisher, Hagopian, Bowman, and Toole, (1996). Gwinn, et al. (2005) specifically assessed the effects of reinforcer delay (i.e. immediate vs. 27-second delay) and increased response effort (i.e. two worksheets vs. one) for high, middle, and low-quality stimuli on task completion for one 7-year old male with Attention Deficit-Hyperactivity Disorder (ADHD). Results supported those of Piazza, et al., (1996) suggesting that PS preference assessments can effectively predict response
allocation across low, medium, and highly preferred stimuli (Gwinn, et al., 2005). As well, high-quality stimuli were associated with responding that was more resistant to reinforcer delay and to increased response effort, however, increased response effort was also associated with higher levels of disruptive behavior and desired effects appeared to become more unstable when the delay period was increased past thresholds likely specific to the individual.

In the present study, for 3 participants with Autistic Disorder, the question was, does reserving access to high quality items for high effort tasks yield more desirable clinical outcomes than providing high quality items for low and high effort tasks? In experiment 1, the differential effects of high and low quality items identified during single presentation pre-session MSWO (DeLeon, et al., 2001) preference assessments on correct responding and disruptive behavior were examined during isolated instructional opportunities of high and low effort tasks. In experiment 2, a pilot study, the same participants were exposed to an instructional sequence more similar to naturally occurring opportunities to evaluate the effects that high quality items delivered during high effort tasks and low quality items delivered during low effort tasks (matched reinforcement), high quality items delivered across low and high effort tasks, and a token only condition had on correct responding and disruptive behavior.

It was hypothesized that during isolated instructional opportunities 1) the delivery of high quality items would more effectively reinforce correct responding relative to low quality and token only conditions for both low and high effort tasks, 2) rate of correct responding would be higher during low effort relative to high effort tasks, and 3) the token only condition would evoke disruptive behavior relative to low and high quality
conditions. Additionally, it was hypothesized that during the final high effort component of 4-sequence instructional opportunities that 1) matched reinforcement would result in higher rates of correct responding relative to high quality or token only conditions, and 2) the token only condition would evoke disruptive behavior relative to high quality and matched conditions.

Experiment 1:
Effects of Varied Reinforcement Quality and Response Effort on Correct Responding During Isolated Instructional Opportunities

Method
Participants and Setting

Two males and 1 female between 6-10 years of age, diagnosed with Autistic Disorder, attending a day treatment facility participated. The participants did not have a previous history of participating in experimental research or using a token economy system and were enrolled in the study after informed consent was received from their parents/guardians.

Peter, an 8-year, 6-month old male is described as communicating via single word utterances and/or a Picture Exchange Communication System. A Licensed Psychological Examiner diagnosed Peter with Autistic Disorder at the age of 45 months.

Mary, a 6-year 2-month old female is described as communicating via single word utterances and/or a Picture Exchange Communication System. Mary was diagnosed with Autistic Disorder at the age of 25 months, by a developmental evaluation team at a local clinic.

Paul, a 9-year, 2-month old male is described as communicating via 1-3 word utterances and/or a Picture Exchange Communication System. Paul was diagnosed with
Autistic Disorder at the age of 34 months, by a neurological evaluation team at a local clinic.

All sessions were conducted in a separate room at the day treatment facility by the primary experimenter. The experimental room contained a large table, two chairs, and four opaque plastic bins containing relevant preference assessment and task materials. A second trained observer recorded interobserver agreement data via videotape during 30% of sessions.

Procedure

Prior to experiment onset, pre-tests were administered to determine low and high effort tasks to be used for each participant. Low effort tasks, identified by participant teachers as “maintenance” tasks, were defined as those that participants completed with between 80-100% accuracy without reinforcement over three pre-test sessions. High effort tasks, identified by participant teachers as “acquisition” tasks, were defined as those that participants completed with between 20-50% accuracy without reinforcement over three pre-test sessions. Tasks were determined individually for each participant and are presented in Table 2.1.

Table 2.1.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Task effort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peter</td>
<td>Sorting big and little items in an array of 2</td>
</tr>
<tr>
<td></td>
<td>Sorting coins in an array of 4</td>
</tr>
<tr>
<td>Mary</td>
<td>Matching letters in an array of 12</td>
</tr>
<tr>
<td></td>
<td>Expressively labeling 2 sets of 10 common object picture cards</td>
</tr>
<tr>
<td>Paul</td>
<td>Sorting utensils in an array of 3</td>
</tr>
<tr>
<td></td>
<td>Sorting coins in an array of 4</td>
</tr>
</tbody>
</table>
Prior to preference assessments, participants were provided with samples of edible and 30-seconds access to leisure items for seven items identified through direct observations and teacher report as potential reinforcers to be used in daily preference assessments within one hour of experimental sessions. The participants were then exposed to a single presentation MSWO preference assessment (DeLeon, et al., 2001). Items were sequenced randomly in a straight line across the table in the experimental room. Items were placed approximately 5 cm apart and participants were seated approximately 0.3 m from the stimulus array. Participants were instructed to “pick one”. Attempts to approach more than one item simultaneously were blocked.

Once selected, participants were allowed to engage with the leisure item for 30-seconds or until consumption (edible item) and the item was not replaced. Prior to the next trial, items were re-sequenced by taking the item on the far left, moving it to the far right, and equally re-spacing all items to approximately 5 cm apart. This method was repeated until all items were selected or 30-seconds passed with no selection made. If any items remained unselected they were marked as Not Selected (NS) and not counted in that day’s ranking. Results indicated a differentiated preference hierarchy for each participant.

**Experimental Design**

During experimental sessions, a sequential multiple schedule design (Wacker, McMahon, Steege, Berg, Sasso, and Melloy, 1990) was utilized to increase experimental control and assist in uncovering functional relations between variables. This design allowed for a) a within subject comparison of the effects of three distinct reinforcement contingencies on rates of correct responding and disruptive behavior and b) an across
subject comparison of rates of correct responding and disruptive behavior during low and high effort tasks. Within and across subject comparison conditions included condition A, token only/low effort items placed on yellow sheets, or pasted on to/correlated with yellow cards; condition B, low quality/low effort correlated with blue; condition C, high quality/low effort correlated with pink; condition D token only/high effort correlated with brown; condition E low quality/high effort correlated with purple; and condition F, high quality/high effort correlated with orange. Sessions, occurred daily, were between 20 and 30 minutes in duration, and counterbalanced across time of day. All session components were introduced with the statements “it’s time to do some work”, “try your best”, “begin”.

Correct responding was indicated by the delivery of a token to a token board corresponding to the condition color, that was kept in the participants’ view during all instructional opportunities. Tokens were delivered on a Fixed Ratio 1 (FR1) schedule. Each token was exchanged for one bite of edible items or 10-seconds with leisure items upon completion of the condition component. The top ranked item for that day identified during the pre-session preference assessment was provided at the end of the component schedule during high quality conditions. The item identified as 5th out of 7 possible items (or the lowest ranked if fewer than 5 items were selected) was provided during low quality conditions. Incorrect responses were not indicated. All condition components were 2-minutes in duration and were presented during each session in random order.

Finally, a “choice” phase was presented to determine which condition participants chose to allocate their responding when all six conditions were presented concurrently. All six versions of color-coded materials were presented concurrently on the floor of the
experimental room. Participants were introduced to the choice phase by the statement “It’s time to do some work. Which one do you want?” The condition represented by the color-coded materials selected was the only condition the participants experienced during the choice session.

Dependent Measures, Independent Variables, and Data Collection

The dependent measures for all participants were rate of correct responding and percentage occurrence of disruptive behaviors (aggression, opposition, leaving the instructional area, and mouthing task materials). Disruptive behaviors were recorded using a 10-second partial interval recording system throughout all sessions via videotape by a human observer using paper, pencil, an individualized data sheet, and an ear bud indicating 10-second intervals with a single tone and a count within continuous 10-seconds interval recording procedure (Johnston & Pennypacker, 1980).

The independent variables included the token system with one token delivered contingently for each correct response on a Fixed Ratio 1 (FR1) schedule, varied reinforcer quality (low/high) exchanged for earned tokens at the end of each session component, and varied task response effort (low/high).

A second independent trained observer collected interobserver agreement (IOA) data during 30% of sessions. IOA for rate of correct responding was calculated by adding correct response tallies over the 2-minute session and dividing by 2, and was 100% across all 3 participants and experiment 1 conditions. For disruptive behavior, three types of IOA (occurrence, nonoccurrence, and total) were calculated to provide an estimate of accuracy in the data collection procedures. For all three types, IOA was calculated on a point-by-point basis by dividing the number of agreements by the number of agreements
plus disagreements and multiplying by 100% across each participant. The mean percent occurrence, nonoccurrence, and total IOA agreements for disruptive behavior during experiment 1 were 95%, 98%, and 97% respectively.

Procedural fidelity checklists filled out after 30% of sessions across conditions and participants indicated that the independent variables were correctly implemented during 97% of sessions.

Results

Experiment 1 results obtained for Peter, Mary, and Paul, expressed as rate of correct responding and percent occurrence of disruptive behavior, are shown in Figures 4.1 and 4.2 respectively.
Figure 4.1.
Figure 4.2.
Peter demonstrated differentiated response patterns between the low and high effort tasks, however within tasks, responding was either highly variable (low effort) or undifferentiated (high effort). Rate of correct responding during LE tasks was lowest for Peter during the TO condition with a mean rate of 6.33 and highest during the HQ condition (mean rate= 8.58). During HE tasks, rate of correct responding was lowest for Peter during the LQ (mean rate= 1.75) and highest during the HQ condition (mean rate= 2.67). Percent occurrence of disruptive behavior was highest for Peter during the LQ/LE condition with a mean of 37% and the TO/HE task with a mean of 32%. Percent occurrence for disruptive behavior was lowest for Peter during the HQ/HE task (mean=5.5%), and second lowest during both the TO/LE (mean=9.67%), and HQ/LE (mean=9.67%).

Mary demonstrated a largely undifferentiated response pattern across all conditions throughout most of experiment 1. However, during the last 3 sessions rate of correct responding during the HQ/HE condition were consistently higher than all other conditions. A potential confound must be noted; namely that Mary was observed to scan the array of 12 potential matches for several seconds during the LE task whereas with the HE task, Mary was presented with one stimulus card at a time, suggesting that a HE task with a task topography more similar to the LE task may have yielded different results. Rate of correct responding during LE tasks was lowest for Mary during the HQ condition with a mean rate of 2, and highest during the TO condition (mean rate= 2.29). During HE tasks, rate of correct responding was lowest for Mary during the TO condition (mean rate= 1.64) and highest during the HQ condition (mean rate= 3.07). Mary engaged in 0% disruptive behavior across all experiment 1 conditions.
Paul demonstrated clearly differentiated response patterns *between* low and high effort tasks, however, less distinct differentiation *within* tasks. In an effort to further analyze the effects of response effort on responding, Paul was exposed to a modified 2-item coin array (nickel and penny), instead of a 4-item array (nickel, penny, quarter, and dime). This modification affected Paul’s rate of correct responding as demonstrated by the discrepant mean rates for the 4-item (TO=1.35, LQ=2.00, HQ=2.10) and 2-item (TO=2.50, LQ=3.50, HQ=4.00) arrays. Rate of correct responding during LE tasks was lowest for Paul during the LQ condition with a mean rate of 6.5, and highest during the HQ condition with a mean rate of 7.54. During HE tasks, rate of correct responding was lowest for Paul during the TO condition with a mean rate of 1.62, and highest during the HQ condition with a mean rate of 3.65. Percent occurrence of disruptive behavior was highest for Paul during the TO/HE condition with a mean of 3.85% and the LQ/HE task with a mean of 1.92%. Paul engaged in 0% disruptive behavior across all other experiment 1 conditions.

Mean rates of correct responding and percentage of disruptive behavior for all participants can be found in Figures 4.3 and 4.4 respectively.
Figure 4.3.
Figure 4.4.
Discussion

During isolated instructional opportunities, results suggest that *between* tasks, response effort had a greater affect on rate of correct responding than quality of reinforcement for Peter and Paul and that quality of reinforcement differentially affected rate of correct responding during the HE condition for Mary.

Consistent with experiment 1 hypotheses, *within* the low effort task, Peter’s rate of correct responding was highest in the HQ condition and lowest in the TO condition suggesting that within LE tasks HQ items more effectively reinforced correct responding relative to LQ and TO conditions. And *within* the high effort task, Peter’s rate of correct responding was highest in the HQ condition, but lowest in the LQ condition suggesting again that HQ items more effectively reinforced correct responding relative to LQ or TO conditions. As well, occurrences of disruptive behavior for Peter were highest in the LQ/LE and TO/HE conditions suggesting that the delivery of lower quality items or no items at the end of the component may have evoked disruptive behavior in these conditions.

Somewhat consistent with hypotheses, Mary’s response patterns were largely undifferentiated across experiment 1 conditions, except during the final 3 sessions in which her rate of correct responding in the HQ/HE condition was consistently higher than all other conditions. This pattern of responding suggests that the quality of items delivered contingently for low effort responding did not effectively reinforce correct responding compared to the TO condition. However, it appears that HQ items did more effectively reinforce correct responding during the HE task relative to LQ and TO conditions.
Also consistent with hypotheses, Paul demonstrated a higher rate of correct responding during the HQ condition relative to other conditions suggesting that the delivery of a highly preferred item contingent on correct responding more effectively reinforced correct responding during both low and high effort tasks. As well, Paul engaged in occurrences of disruptive behavior during the TO/HE and LQ/HE conditions only suggesting that providing no or low quality items contingent on high effort responding was more likely to evoke disruptive behavior than other conditions.

Experiment 2:
A Pilot Study of the Effects of Matched and High Quality Reinforcement and Response Effort on Correct Responding During the Final High Effort Component of Sequenced Instructional Opportunities

*Participants, Procedure and Experimental Design*

Peter, Mary, and Paul also participated in experiment 2. In experiment 2, participants were again exposed to the single presentation MSWO preference assessment (DeLeon, et al., 2001) with 1st and 5th ranked items constituting high and low quality stimuli respectively for that day, with access to the 1st and 5th ranked items provided at the end of each relevant component session. Tokens were delivered on a FR 1 schedule for correct responding across instructional sequences consisting of 4, 2-minute components in a sequential multiple schedule design.

However, instead of randomly alternated ABCDE and F conditions, participants experienced a sequence that more closely approximates naturally occurring instructional opportunities correlated with different contingencies of reinforcement across 3 conditions. The instructional sequence consisted of low and high effort tasks (LE/HE) in
the following arrangement LE-LE-LE-HE. The tasks in experiment 2 included the same low and high effort task for each participant from experiment 1 in addition to 2 other low effort tasks that met pre-test requirements. These additional tasks are presented in Table 5.1. In condition A2 (token only/sequence-TO/SQ, correlated with the color black), reinforcement in the form of edible or leisure items was not delivered. In condition B2 (Matched reinforcement/sequence- M/SQ, green), reinforcer quality was low for low effort tasks and high for the high effort task, and in condition C2 (HQ/SQ, red), reinforcer quality was high across all conditions of the sequence.

Table 5.1.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Low effort task</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peter</td>
<td>Sorting dishes in an array of 3</td>
<td>Sorting utensils in an array of 3</td>
</tr>
<tr>
<td>Mary</td>
<td>Sorting coins in an array of 4</td>
<td>Matching shapes in an array of 9</td>
</tr>
<tr>
<td>Paul</td>
<td>Sorting dishes in an array of 3</td>
<td>Sorting socks and washcloths in an array of 2</td>
</tr>
</tbody>
</table>

Dependent Measures, Independent Variables, and Data Collection

The dependent measures for all participants were again rate of correct responding, and percent occurrence of disruptive behaviors. Disruptive behaviors were recorded using the same 10-second partial interval recording system.

Experiment 2, independent variables included single presentation MSWO preference assessments (DeLeon, et al., 2001) within one hour of each session, the token system with tokens delivered on a FR1 schedule, the LE-LE-LE-HE instructional sequence, and varied reinforcer quality (matched/high).
IOA for rate of correct responding was 100% across all 3 participants and experiment 2 conditions. The mean percent occurrence, nonoccurrence, and total IOA agreements for disruptive behavior during experiment 2 were all 100%. Procedural fidelity checklists filled out after 30% of sessions across conditions and participants indicated that the independent variables were correctly implemented during 100% of sessions.

Results

Experiment 2 results obtained for Peter, Mary, and Paul, expressed as rate correct and percentage occurrence of disruptive behavior during the final HE component, are shown in Figures 4.1 and 4.2 respectively.

Rate of correct responding was highest during the Matched (M/SQ) condition (mean=1.95), and lowest during the Token Only/Sequence (TO/SQ) condition (mean= 1) for Peter. The percentage occurrence of disruptive behavior was highest during the TO/SQ condition (mean= 53.4%). In an effort to determine if disruptive behaviors were evoked during the TO/SQ condition, the TO/SQ condition was removed and Peter was only exposed to the M/SQ and HQ/SQ conditions. Once the TO/SQ condition was removed, mean percentage occurrence of disruptive behavior decreased from 20.75 to 19.33 during the HQ/SQ condition and increased during the M/SQ condition from 8.75 to 47.33. As well, mean rate of correct responding decreased from 2.13 to 1.67 during the HQ/SQ condition and during the M/SQ condition from 2.00 to 1.17.

When the TO/SQ condition was re-introduced percentage occurrence of disruptive behavior during the TO/SQ condition was 92, decreased in the M/SQ condition from 47.33 to 0, and increased in the HQ/SQ condition from 19.33 to 100. The mean rate
of correct responding when the TO/SQ condition was reintroduced was 0.5 in the TO/SQ, 4 in the M/SQ, and 0 in the HQ/SQ condition. The TO/SQ condition was then once again removed and the mean rate of correct responding was 2 in the M/SQ and 0.75 in the HQ/SQ conditions. Mean percentage occurrence disruptive behavior, when the TO condition was again removed, was 29% in the M/SQ and 87.5% in the HQ/SQ conditions.

Rate of correct responding was highest for Mary in the HQ/SQ (mean= 3.57), second highest in the M/SQ (mean= 3.43), and lowest in the TO/SQ (mean= 3.07) condition. However, rate of correct responding was most stable during the TO/SQ condition suggesting that the delivery of tokens may have been functioning as a generalized conditioned reinforcer. To further test this hypothesis, the tokens were removed from the TO/SQ condition. However, when the TO/SQ condition was run without token deliveries mean rate of correct responding during the TO/SQ condition increased from 2.83 to 3.5. Tokens were then reintroduced and response rate during the TO/SQ condition stayed at 3.5. The tokens were once again removed and rate of correct responding during the TO/SQ condition decreased to 2.5. Mary engaged in 0% occurrences of disruptive behavior during the TO/SQ and HQ/SQ conditions. During the M/SQ condition, Mary engaged in a mean percent occurrence of disruptive behavior of 1.14.

Paul demonstrated undifferentiated response patterns across experiment 2 conditions. However, overall, Paul’s mean rate of correct responding was highest in the HQ/SQ (3.33), next highest in the TO/SQ (2.67) and lowest in the M/SQ (2.5) condition.
Paul engaged in 0% occurrences of disruptive behavior during the HQ/SQ, a mean percentage of 2.43 in the M/SQ, and 16.67 in the TO/SQ conditions.

Mean rates of correct responding and percentage of disruptive behavior during experiment 2, for all participants can be found in Figures 6.1 and 6.2 respectively.
Figure 6.1.
Figure 6.2
Discussion

Overall results suggest that M/SQ and HQ/SQ conditions more effectively reinforced correct responding in the final HE component of a 4 component instructional sequence than the TO/SQ condition for Peter, Mary, and Paul.

Consistent with experiment 2 hypotheses, Peter’s results suggest that the TO/SQ condition evoked disruptive behavior relative to M/SQ and HQ/SQ conditions. When the TO/SQ condition was removed, disruptive behavior occurred more frequently in the M/SQ condition and rate of correct responding decreased in both the M/SQ and HQ/SQ conditions. When the TO/SQ condition was reintroduced, disruptive behavior occurred at a high rate in the TO/SQ and throughout the HQ/SQ conditions. However, disruptive behavior decreased to 0% in the M/SQ condition and rate of correct responding was again highest in the M/SQ condition. The TO/SQ condition was once again removed and Peter’s response pattern indicated an increase in disruptive behavior in the M/SQ, a decrease in disruptive behavior in the HQ/SQ condition relative to when the TO/SQ was presented, but he maintained a higher rate of correct responding in the M/SQ condition relative to the HQ/SQ condition. These results suggest that matched reinforcement may result in higher rates of correct responding for Peter, however, reserving access to HQ items until the final HE component may also evoke disruptive behavior relative to providing access to HQ items across an instructional sequence.

For Mary, mean rate of correct responding was highest in the HQ/SQ, second highest in the M/SQ, and lowest in the TO/SQ condition. These results suggest that both HQ/SQ and M/SQ reinforcement effectively supported higher rates of correct responding relative to the TO/SQ condition. As responding was more stable in the TO/SQ condition,
it was hypothesized that the delivery of tokens may have been affecting Mary’s rate of correct responding by functioning as a generalized conditioned reinforcer. Further experimental analysis of this hypothesis indicated that in fact the tokens were not affecting Mary’s rate of correct responding. Further, Mary engaged in 1.14% occurrence of disruptive behavior during the M/SQ condition and no occurrences of disruptive behavior in either the TO/SQ or HQ/SQ conditions, suggesting that the delivery of LQ items during the first 3 components of an instructional sequence may have evoked a low level of disruptive behavior during the final HE component relative to TO/SQ and HQ/SQ conditions.

Additionally, Mary was observed to engage in high levels of physical stereotypy that appeared to have been automatically reinforced, across all conditions and with or without the contingently delivered LQ or HQ items. However, the definition of disruptive behavior did not include physical stereotypy and duration of engagement with preferred items during the end of component earned time was not measured. Thus, it is possible that Mary did not actually contact different reinforcement contingencies, and that HQ reinforcement was in fact delivered across all conditions via permitted engagement in stereotypy after each component. This may explain Mary’s undifferentiated response patterns and performance in the TO conditions across experiments 1 and 2 and may have adversely affected Mary’s performance across all conditions.

Charlop, Kurtz, and Casey (1990) used a multielement design across 3 conditions to compare the efficacy of using edibles, aberrant behavior (stereotypy, echolalia, perseverative behavior), or varied (edibles or aberrant behavior) as the reinforcer to increase correct responding. Results suggest that correct responding was highest when
brief (3-5 s) periods of permitted aberrant behavior were used as the contingent reinforcer and that no negative side effects, such as an increase in aberrant behaviors, occurred. Therefore, Mary’s results may have been different if engagement in stereotypy was used as the HQ reinforcement. It is thus critical, as Mary’s case may illustrate, for work in applied settings, that even if practitioners identify HQ items using a preference assessment that students contact the reinforcement to effectively support desired behavior change.

Consistent with experiment 2 hypotheses, Paul engaged in 0% occurrences of disruptive behavior during the HQ/SQ, a low level of occurrence in the M/SQ, and the highest percentage in the TO/SQ condition, suggesting that the delivery of low quality or no items during initial components evoked disruptive behavior relative to the HQ/SQ condition. Contrary to experiment 2 hypotheses, Paul’s rate of correct responding was highest in the HQ/SQ, next in the TO/SQ, and lowest in the M/SQ condition, suggesting that within an instructional sequence, high quality reinforcement across all 4 components more effectively supported higher rates of correct responding during the final HE component than TO/SQ or M/SQ conditions. These results also suggest that for Paul, access to high quality items during low effort tasks prior to the introduction of a high effort task did not adversely impact reinforcer effectiveness.

General Discussion and Limitations

Three hypotheses were evaluated during isolated instructional opportunities in experiment 1. First, that the delivery of HQ items would more effectively reinforce correct responding relative to LQ or TO conditions for both LE and HE tasks. Participant responding for Peter and Paul supported this hypothesis across both LE and HE tasks,
and HE tasks with Mary only. Second, that rate of correct responding would be higher during LE relative to HE tasks, which was true for Peter and Paul but not for Mary. And finally, that the TO condition would evoke disruptive behavior relative to LQ and HQ conditions, which again was true for Peter and Paul but not Mary.

During a pilot study using 4-sequence instructional opportunities in experiment 2, 2 hypotheses were evaluated. First, that the M/SQ condition would result in higher rates of correct responding relative to HQ/SQ and TO/SQ conditions. Peter’s responding supported this hypothesis, however for Mary and Paul, the HQ/SQ condition resulted in higher rates of correct responding than the M/SQ, and for Paul, rate of correct responding was lowest in the M/SQ condition. And finally, that the TO/SQ condition would evoke disruptive behavior relative to HQ/SQ and M/SQ conditions. Peter and Paul’s response patterns supported this hypothesis, however for Mary the M/SQ condition was the only condition in which disruptive behavior occurred.

Therefore, results for all 3 participants across experiment 1, provide additional support for previous research suggesting that quality is an important reinforcer dimension to consider when arranging environments to occasion higher rates of desired responding (Pace, et al., 1985; Mason, et al., 1989; Roscoe, et al., 1999; DeLeon and Iwata, 1996), and that high quality items can be less susceptible to the effects of increased response effort or schedule requirements (Gwinn, et al., 2005; Glover, et al., 2008; Penrod, et al., 2008). Results, for 2 out of 3 participants, are also consistent with research suggesting that increased response effort can effectively decrease rate of responding relative to lower effort tasks (Richman, et al., 2001; Irvin, et al., 1998; Neef, et al., 1994; Lannie and Martens, 2004; Mace, et al., 1996).
As well, experiment 2 results extend previous research suggesting that for 1 out of 3 participants, matched reinforcement more effectively increased rate of correct responding relative to high quality or token only conditions during an instructional sequence. This experiment combines research on establishing operations and instability of preference over time and across different contexts (Egel, 1981; Hanley, et al., 2006; Kodak, et al., 2007; Gottshalk, et al., 2000) with the effects of response and reinforcement dimensions on correct responding and disruptive behavior. The results of this experiment contribute to a methodology of matched reinforcer delivery based on the Matching Law that may have potentially important implications for the consideration of quality of reinforcement and response effort in applied settings.

In summary, collectively, these data suggest that reserving access to high quality items for high effort tasks yielded more desirable clinical outcomes for 1 of 3 participants. As well, these data suggest that when designing reinforcement supports, consideration of different reinforcement and response variables relevant to the individual is necessary. Individualized reinforcement supports can then be prescribed based on assessment results. This concept of prescribed reinforcement is conceptually consistent with Steege, Wacker, Berg, Cigrand, and Cooper (1989), who used reinforcer assessment and functional analysis or behavioral assessment results to prescribe treatments for 2 children with severe disabilities who engaged in self-injurious behavior. The results of the present study were used to prescribe participant specific reinforcement contingences for low and high effort tasks.

Prescriptive reinforcement designed to increase rate of correct responding for the specific low and high effort tasks assessed during isolated instructional opportunities for
Peter and Paul would thus consist of delivering high quality items across low and high effort tasks, and for Mary to provide tokens only during low effort tasks and high quality items during high effort tasks. Prescriptive reinforcement designed to increase rate of correct responding for the specific tasks assessed during an instructional sequence for Peter would consist of providing matched reinforcement, and for Mary and Paul to provide high quality items across the instructional sequence.

This method of assessing which reinforcement and response dimensions affect rate of correct responding and disruptive behavior and using assessment results to design and prescribe participant specific reinforcement supports has important implications for applied work. Prescriptive strategies can potentially lead to increased reinforcer efficacy and fewer occurrences of disruptive behavior during academic instruction.

These results must be interpreted with caution however, due to several limitations. One major limitation of this study included the use of the single presentation MSWO preference assessment method. This procedure was utilized because the preference assessments were conducted so frequently that a full MSWO assessment was deemed too cumbersome. However, the extent to which the top and 5th ranked item for each day’s session accurately represented high and low quality items may have confounded the results as neither in this study nor in the study conducted by Deleon, et al. (2001) was the single presentation method directly compared to established preference assessment methods. Future research efforts should attempt to answer the same questions about the effects of prescriptive reinforcement on correct responding and disruptive behavior, while evaluating the effectiveness of the time efficient single presentation MSWO method.
compared to more time consuming standard MSWO and PS preference assessment methods.

Another major limitation of this study includes that the multiple schedule design consisted of conducting multiple condition sessions per day. The extent to which carryover effects contributed to results is unknown. However, carryover effects could have contributed to unexpected response patterns, such as Peter’s responding in experiment 2. Disruptive behaviors for Peter evoked during the TO condition were also anecdotally observed to increase the likelihood that disruptive behaviors would occur during the matched and/or high quality conditions that followed the TO condition. If these conditions had been sequenced across days these effects may have been minimized.

A final limitation included that the duration of engagement with preferred items during earned time was not measured. This would have provided potentially important information, particularly for Mary, as she was observed to engage in high levels of physical stereotypy during earned time with preferred items. Mary’s results may have been different if engagement in stereotypy was used as the HQ reinforcement.

In conclusion, and extending on experiment 2, subsequent research might further examine the utility of matched reinforcement in applied settings, across different populations, tasks, and effort levels required to respond. As well, future investigation efforts might evaluate the effectiveness of matched reinforcement in conjunction with assessment efforts that would allow for timely responding to dynamic, naturally occurring shifts in preference due to changes in motivating operations over time and across contexts.
References


Author note

Elizabeth Zook, born in Columbus, Ohio graduated from the Columbus School for Girls in 1998, The University of Oregon in 2002 with a B.S. in Anthropology and a minor in Special Education, The Flinders University in 2003 with a M.S. in Special Education, and The University of Southern Maine with a Certificate in Applied Behavior Analysis and M.S. in Educational Psychology, 2009. Elizabeth Zook is currently a Board Certified Assistant Behavior Analyst and Certified Special Education Teacher working at the Margaret Murphy Center for Children in Lewiston, Maine. She is a candidate for the Doctor of Psychology degree in School Psychology from The University of Southern Maine in August, 2010.