TIME-BASED VERSUS TASK-BASED CONTINGENCIES: WHICH IS MORE EFFECTIVE FOR INDEPENDENT ACADEMIC ASSIGNMENTS?

A Dissertation in
Special Education

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Submitted in Partial Fulfillment of the Requirements for the Degree of

Doctor of Philosophy

August 2008
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**ABSTRACT**

Task interspersed is an academic material modification procedure designed to make task completion more reinforcing. It is implemented by adding a sequence of brief tasks prior to more difficult or nonpreferred target academic tasks. This procedure results in an increase in the number of conditioned reinforcers available for completing a given task. However, one limitation of the studies examining these effects is that researchers exclusively use time-based contingencies to study academic choice behavior. This procedure may (a) inadvertently limit student opportunities to respond to the target problems and (b) not accurately reflect the real contingencies in applied settings. The purpose of this study is to investigate the effects of time- and task-based contingencies on student choice of academic materials. In this study a concurrent-schedule design with a reversal was used to compare the students' choice of worksheets when working under different task contingencies.

Overall, the results showed that during the task-constant condition all three students had the same clear preference for the traditional worksheets. However, their preferences of task material during the time-constant condition were individualized. In addition, two of the students had higher digits correct per minute (DCPM) during the task-constant condition regardless of the task format and one student had higher DCPM on both types of worksheets during the time-constant condition. Results are discussed within the context of matching law and previous literature. Limitations of the study are also listed. Finally, implication for practitioner and teachers are delineated.
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I would like to express my deep appreciation to many individuals who have made this dissertation possible. My deepest gratitude is to my advisor, Dr. David Lee. I have been very fortunate to have an advisor who gave me the freedom to explore on my own and at the same time provided guidance. His profound knowledge and excellent mentorship helped me complete this program successfully. I hope that one day I will become as good of an advisor to my students as Dr. Lee has been to me.

I am grateful to Dr. James McAfee for his insightful comments and feedback at different stages of my research. He put things into perspective and constantly reminded me of the beauty of parsimony. More importantly, I feel incredibly fortunate to have worked with Dr. McAfee throughout my entire doctoral program. His mentorship and friendship helped me overcome many crisis.

I would like to thank Dr. Mary Catherine Scheeler for her careful reading and commenting on this manuscript. She held me to a high standard and encouraged and guided me to meet the standard.

I am greatly thankful to Dr. John Regan for his feedback on this manuscript. He helped me enrich my ideas and clarify the manuscript.

I am also indebted to Sam Stansbery, one of the best teachers that I have seen in my life. I could not have completed this study without his assistance.

I would like to thank the Department of Special Education at the Penn State University for providing me with such a great opportunity for the doctoral education. I could not have completed my program without their financial support.
It is my friends who have made my graduate education at Penn State more enjoyable, particularly my two best friends, Mandy Kubo Carranza and Katie Hildebrand Hoffman. They were not only the first reviewers of my paper, first audience of my presentation, and reliability checker of the study but also have become part of my family. I am forever grateful for their friendship.

Most importantly, none of this would have been possible without the love and support of my family. My parents to whom this dissertation is dedicated to, have been a constant source of love and strength all these years. Their unconditional love and support and confidence in me has always guided me on my life journey.
CHAPTER 1

Introduction

Researchers have continued investigations of the methods that most efficiently and effectively promote academic competence. One area identified by researchers as a key component of academic achievement is opportunities to respond via independent academic assignments (Trautwein & Koeller, 2003; Trautwein, Koeller, Schmitz, & Baumert, 2002). Haring and Eaton (1978) suggest that drill and independent practice are valuable procedures because they are critical instructional components used in all stages of learning. For example, during skill acquisition, independent seatwork in combination with demonstration and modeling allows the learner to acquire new skills successfully and efficiently (Smith, 1973). After a skill has been acquired, the learner can reach fluency through active and repeated responding to academic assignments (Skinner, 1998). Academic assignments also facilitate generalization and adaptation. For example, activities designed to practice previously learned skills in the solution of new problems make the skills functional in daily life (Blake, 1974). Clearly, maximizing the benefits of independent academic assignments is critical for both teachers and students.

The effectiveness of independent academic assignments is directly related to the rate of active responding on those assignments, as frequent opportunities to respond increase academic achievement (Greenwood, Delquadri, & Hall, 1984). This finding implies that students should be placed in learning situations that promote (a) active responding and (b) high rates of correct responding. For example, during independent
work students should respond at a rate of 9 to 12 responses per minute with a minimum accuracy of 90% (Stephens, 1976). Unfortunately, students with learning difficulties tend to complete assignments more slowly, far below the recommended rate, with a lower accuracy: correct responses range from 20-76% (Carpenter-Aeby & Aeby, 2001; Stephens, 1976; Umbreit, Lane, & Dejud, 2004).

After examining the low number of correct responses for students with learning difficulties, Skinner, Pappas, and Davis (2005) suggested that these students have either a skill deficit (i.e., the students do not possess the skills needed to perform a given task) or a performance deficit (i.e., the student possesses the skills, but chooses not to complete a given task). This distinction is important because interventions for skill deficits may be very different from interventions employed with performance deficits. Teachers can remediate student skill deficits by providing instruction designed to aid in the acquisition of the specific skill. On the other hand, if a student has the prerequisite academic skills to complete an assigned task, engagement is a choice. That is, the student may be able to perform the assigned task, but simply chooses not to do so.

In any academic situation students are confronted with a series of choices: Should I complete an assignment or talk to my friend? Should I talk to my friend or throw a paper ball at another student? The selection of one activity over another is determined by the relative amount of reinforcement associated with each alternative (Herrnstein, 1961). For example, if engaging in undesirable behaviors is relatively more reinforcing than completing an assigned task, students are more likely to engage in behaviors that disrupt the learning environment. Conversely, if task engagement is relatively more reinforcing than engaging in undesirable classroom behaviors students are more likely to complete
assigned tasks. For students with learning difficulties, reinforcers contingent upon assignment completion are delivered at relatively low rates because these students are either not able to complete the tasks or complete the tasks slowly (Sutherland, Alder, & Gunter, 2003; Van Acker, Grant, & Henry, 1996). It is not surprising that students with learning difficulties are less likely to choose to complete academic assignments over other alternatives, given the relatively low payoff for completing these assignments compared with other options available in the student’s environment. In choosing other alternatives, students rarely receive the benefits of added practice, which ultimately affects future academic achievement (Skinner, Robinson, Adamson, Atchison, & Woodward, 1998; Stanovich, 1986) and results in an iterative process where failure begets reluctance and reluctance begets additional failure. What starts out as a “won’t do” problem (performance deficit) soon becomes a “can’t do” problem (skill deficit), which further perpetuates the cycle of academic difficulties. In order to break this cycle of academic failure it is important to create learning conditions whereby students choose to complete independent academic assignments over other options because they are more likely to obtain reinforcement associated with academic task completion.

Researchers and practitioners have employed various strategies to make academic task completion more appealing. For example, some researchers found that delivering tangible reinforcers and attention contingent upon task completion increased assignment completion (Mace, McCurdy, & Quigley, 1990; Martens, Halperin, Rummel, & Kilpatrick, 1990; Neef, Mace, & Shade, 1993; Neef, Mace, Shea, & Shade, 1992). Students in these studies chose to complete academic tasks because the magnitude of reinforcement associated with these academic tasks was greater than the level associated
with other activities in the classroom. Although effective, practitioners may find it difficult to implement these procedures in applied settings because they require continuous observation and delivery of reinforcers contingent upon each student’s behavior (Skinner, 2002).

Practitioners can also increase student selection of academic tasks by reducing task requirements, thus making task completion less difficult. For example, replacing difficult target problems with easier, briefer, and previously mastered tasks (Cooke, Guzaukas, Pressley, & Kerr, 1993; Winterling, Dunlap, & O'Neill, 1987), likewise, making assignments shorter (Horner & Day, 1991; Kern, Childs, Dunlap, Clarke, & Falk, 1994; Lovitt & Hansen, 1976) can improve students’ on-task behavior and task completion because students are more likely to meet criterion for reinforcement. Although effective at increasing academic productivity during the short-term, techniques that reduce task requirements for students who are already behind academically may be counter-productive (Dunlap & Kern, 1996; Logan & Skinner, 1998) as one predictor of academic achievement is content coverage (Skinner, Fletcher, & Hennington, 1996a).

Given the potential procedural drawbacks of delivering tangible reinforcers and the academic drawbacks of reducing task requirements, what is needed is an intervention that makes task completion more reinforcing without the problems associated with watering down the curriculum (i.e., requiring less work). The literature on task interspersal may provide such an intervention.

Task interspersal is a group of academic material modification procedures that are implemented by adding a sequence of brief tasks prior to more difficult or nonpreferred target academic tasks. This procedure is based on the discrete task completion hypothesis
(DTCH) proposed by Skinner (2002). Skinner posits that completed assignments act as reinforcing stimuli. Moreover, each individual problem within an assignment becomes a conditioned reinforcer through pairing with teacher-delivered reinforcers for assignment completion. For example, most students have a learning history where assignment completion is accompanied by reinforcers. A teacher may provide verbal praise or extra computer time for assignment completion. Each problem in the assignment becomes a potential conditioned reinforcer as completion of individual tasks ultimately results in attainment of the reinforcer from the teacher (i.e., praise and extra computer time). Thus, the speed at which individual problems can be completed determines the rate of reinforcement the student will receive.

Interspersal procedures take advantage of the effects of discrete tasks as potential reinforcers by embedding brief tasks that take little effort to complete and have a history as a conditioned reinforcer among targeted academic tasks. This procedure results in an increase in the number of conditioned reinforcers available for completing a given task. As an illustration, an assignment consisting of ten difficult math problems that takes a total of 10 minutes to complete will provide ten conditioned reinforcers (one for each problem completed). The rate of reinforcer delivery for the assignment is about 60 per hour. If an additional 5 brief problems, each taking 10 seconds to complete, are added to the same task, the rate of reinforcement increases to about 84 per hour, thus increasing reinforcement density. Consequently, students may be more likely to choose the interspersed assignment over other options available in the environment, because the interspersed assignment provides a richer schedule of reinforcement. Using the DTCH as a framework for redesigning academic assignments, researchers have found that students
are more likely to choose interspersed assignments (Cates et al., 1999; Teeple & Skinner, 2004; Wildmon, Skinner, Watson, & Garrett, 2004). Students in these studies chose the interspersed worksheets because the modified assignments were perceived as (a) requiring less time and effort, (b) less difficult, and (c) more preferred.

The emerging research base for using task interspersal to help students choose academic assignments over other activities is promising. However, one limitation of the studies examining these effects is that researchers often use time-based contingencies to study academic selection behavior. That is, they hold the time required to complete traditional and interspersed worksheets constant across experimental conditions. This procedure may inadvertently limit student opportunities to respond to the target problems on the interspersed worksheets because the students had to spend extra time working on the additional brief tasks, leaving less time to complete the target problems on the worksheets. Use of only time-based contingencies also may not accurately reflect the real contingencies in applied settings. In typical classrooms, teachers generally use a mix of time-based (e.g., “Work on this assignment for 10 minutes.”) and task-based (e.g., “Finish these 10 problems.”) contingencies. When task-based contingencies are used, interspersal worksheets may take more effort because, in addition to the equal number of difficult tasks to be completed, students also need to complete additional interspersed brief tasks. Therefore, task materials and contingencies may interactively affect student choice (Lannie & Martens, 2004; Rosenberg, Sindelar, & Stedt, 1985).

In an effort to account for student selection behavior across assignment formats this study was designed to further investigate the effects of interspersal procedures with different task contingencies. Specifically, this research addresses the following question:
What are the effects of time- and task-based contingencies on student choice of traditional and interspersal academic materials?
CHAPTER 2

Review of Literature

This literature review addresses three questions: (a) How was the interspersal procedure implemented? (b) What are the effects of the procedure? (c) What is the underlying mechanism of the effectiveness of the procedure? This chapter provides a summary of studies in which the interspersal procedure was implemented. This review also analyzes the underlying behavioral mechanisms in the context of the discrete task completion hypothesis and the matching law. Finally, research questions evolving from the literature review are stated.

Inclusion Criteria

Task interspersal is an academic material modification procedure that is implemented by embedding sequences of already learned academic tasks between the tasks to be learned or practiced. The interspersal procedure has two models – the additive model and the substitutive model. Substitutive interspersal replaces acquisition tasks (target tasks) with tasks that the student has already mastered (maintenance tasks). For example, Cooke and Guzaukas (1993) studied task interspersal during training of new spelling words. During baseline sessions, participants were given 10 new words (acquisition tasks). Researchers then implemented task interspersal by giving the participants seven known (K) words (i.e., previously learned) and three randomly selected unknown (U) words presented in this sequence: K-K-K-U-K-K-U. Researchers found that substitutive interspersal procedures increased student acquisition of new academic skills (e.g., Cooke & Reichard, 1996; Neef, Iwata, & Page, 1977; Roberts, Turco, & Shapiro, 1991).
On the other hand, additive interspersal procedures have been predominantly used to make academic materials more appealing so that students are more likely to choose assignments over other options available in the environment. Researchers implemented additive interspersal procedures by embedding additional tasks (maintenance tasks) to worksheets without reducing the number of tasks to be learned. For example, the additive interspersal models alter the aforementioned spelling words training as K-U-U-U-K-U-U-U-K-U-U-K-U-U. Unlike the substitutive interspersal procedure, additive interspersal does not compromise task integrity because it does not reduce student opportunities to respond to the target tasks (Billington & Skinner, 2006; Skinner, 2002).

The following is a review of the additive interspersal literature and its effects on student choice of assignments. The review contains research meeting the following criteria:

(1) The experiments were published in refereed journals.

(2) The interspersal assignments used in the experiments contained the same number and type of target tasks as the control assignments. Studies investigating the strength of interspersal procedure in which researchers added more target tasks to the interspersal worksheets were excluded (e.g., Billington & Skinner, 2002; Cates & Skinner, 2000; Cates et al., 1999; Meadows & Skinner, 2005).

(3) Participants’ choice of either traditional or interspersal assignments was recorded as one of the dependent variables. Research was excluded if it did not include choice of assignment as a dependent variable (e.g., Calderhead, Filter, & Albin, 2006; Cates et al., 2003; Hawkins, Skinner, & Oliver, 2005; Johns, Skinner, & Nail, 2000;
Participants worked on both types of the assignments (i.e., traditional and interspersal worksheets) under the same condition (e.g., for equal amount of time or assignment completion). Studies in which students completed the control and interspersal worksheets under different experimental conditions were excluded (e.g., Clark & Rhymer, 2003; Rhymer & Cates, 2006; Rhymer & Morgan, 2005).

Reviewed Studies

Seventeen studies met the aforementioned criteria. Researchers in twelve studies evaluated the effects of interspersal procedures on student choice of task materials across academic domains (Billington, Skinner, & Cruchon, 2004a; Billington, Skinner, Hutchins, & Malone, 2004b; Logan & Skinner, 1998; Martin, Skinner, & Neddenriep, 2001; McDonald & Ardoin, 2007; Robinson & Skinner, 2002 Experiment 1 and 2; Skinner, Robinson, Johns, Logan, & Belfiore, 1996c Experiment 1; Teeple & Skinner, 2004; Wildmon, Skinner, McCurdy, & Sims, 1999; Wildmon, Skinner, & McDade, 1998; Wildmon et al., 2004). Researchers in five studies investigated the mechanism responsible for effects of interspersal procedure demonstrated earlier by varying the characteristics of the interspersed tasks (Skinner, Fletcher, Wildmon, & Belfiore, 1996b; Skinner et al., 1999; Skinner et al., 1996c Experiment 2) and quantity of the interspersed tasks (Cates & Dalenberg, 2005; Cates & Erkfritz, 2007). Appendices A and B display features of the reviewed research.
Analysis

Implementation of Interspersal Interventions

Researchers have investigated the effects of interspersal interventions on student choice of math computation assignments (Billington et al., 2004a; Billington et al., 2004b; Logan & Skinner, 1998; McDonald & Ardoin, 2007; Robinson & Skinner, 2002; Skinner et al., 1996c Experiment 1; Wildmon et al., 2004). For example, Logan and Skinner (1998) had 30 sixth-grade students work on both control and interspersal worksheets. Control worksheets contained 25 four-digit by one-digit multiplication (4 x 1) problems. Logan and Skinner developed a packet of matched experimental worksheets (interspersal worksheets) containing the same number and type of 4 x 1 digit problems. On the experimental worksheets, researchers embedded nine extra one-digit by one-digit addition (1 x 1) problems, each 1 x 1 task followed by three 4 x 1 tasks (e.g., 2 + 3 = ___, 2569 x 3 = ___, 7256 x 4 = ___, 9365 x 9 = ___). Researchers presented both types of assignments in counterbalanced order across students. The students were told that they needed to work on both of the assignments for 8 min. Both control and experimental worksheets contained more problems than students could complete in 8 min. After the students worked on both types of worksheets, researchers asked them to choose one additional assignment (either control or experimental) to complete. Students were informed that the assignment would not be the same as those they had just completed but would contain the same type, number, and sequence of problems. Logan and Skinner reported that students completed more total problems (target and interspersed tasks) on the interspersal worksheets and significantly more students chose the interspersal worksheets as the additional assignment. Researchers found similar results when
interspersing additional one-digit by one-digit multiplication (1 x 1) tasks among multiple-digit multiplication tasks (Billington et al., 2004a; Billington et al., 2004b; McDonald & Ardoin, 2007; Skinner et al., 1996c Experiment 1), one-digit by one-digit subtraction tasks (1 x 1) among multiple-digit subtraction tasks (Wildmon et al., 2004), and two-digit by one-digit (2 x 1) tasks among more difficult mental computation tasks (Robinson & Skinner, 2002).

Researchers have also implemented interspersal procedures on worksheets containing math word problems. For example, Wildmon, Skinner, McCurdy and Sims (1999) and Wildmon, Skinner, and McDade (1998) developed two types of math word problem assignments. The control assignment contained eight word problems requiring multiple-step operations (e.g., two-digit x two-digit + two-digit x two-digit) with an average of 71 words per reading problem. The experimental assignment contained eight equivalent 2 x 2 + 2 x 2 word problems plus three additional short word problems that required one operation (e.g., four-digit by four-digit addition). Each interspersed short word problem preceded a series of two to three target tasks (long word problems). The length of each short word problem was an average of 18 words. The researchers asked students to work on both of the assignments for equal amounts of time, but not enough to complete either of the assignment. The researchers also counterbalanced the order of both control and experimental worksheets across the participants. After the students spent 640 seconds on both assignments, the researchers asked the students to choose an assignment (either control or experimental) that would contain the same type, number, and sequence of problems as a homework assignment. Results from each study showed that students
completed more total problems (target and interspersed tasks) on interspersal worksheets and significantly more students chose interspersal worksheets as homework assignments.

Although researchers implemented interspersal procedures primarily on math assignments, two of the included studies also extended interspersal research to language arts assignments (Teeple & Skinner, 2004) and passage reading (Martin et al., 2001). Teeple and Skinner used a 15-paragraph grammar assignment as the control assignment. Each paragraph had four sentences and the number of letters in each paragraph varied from 118 to 143. Interspersal worksheets contained eight one-sentence paragraphs. The length of each short paragraph was two words (an average of 10 letters per paragraph). Each interspersed paragraph was placed immediately prior to the two target paragraphs (multiple-sentence paragraph). The researchers asked the students to copy the paragraphs and add punctuations to the end of each sentence on both control and experimental assignments. Both assignments contained more tasks than the students could complete in 15 min. After students worked on each assignment for 15 min, researchers asked the students to choose a worksheet as a homework assignment. Similar to the effects of interspersal research in math, Teeple and Skinner found that interspersal assignments increased the total number of paragraphs completed (both target and interspersed) and significantly more students chose the interspersal assignment for homework. On the other hand, Martin et al., (2001) failed to replicate interspersal effects when the procedure was implemented to a whole passage reading assignment. The control reading passage used by the Martin et al. contained three paragraphs with an average of 173 words. Researchers added two separate lower grade level short paragraphs (16 words per paragraph) to the control passage. Each target paragraph was followed by a short target
paragraph on the experimental passages. Students were instructed to read out loud until they finished the whole passage. After the students finished reading both control and interspersal passages, researchers asked the students which type of reading assignment they preferred. Martin et al., found that the number of words read correctly per minute across the two types of passages was not different. In addition, they found that number of students who liked experimental passages was not statistically different from the control passage. Martin et al. recommended that interspersal procedures be implemented on assignments containing multiple discrete tasks (e.g., math worksheets) instead of one continuous task (i.e., passage reading).

Mechanism of Interspersal Intervention

The aforementioned research indicates that interspersal procedures may increase the rate of total problem completion on worksheets containing multiple discrete tasks across different academic domains and also increase the likelihood of student choice of the material. However, none of the researchers directly investigated the mechanism responsible for the effects of the interspersal procedure. This leads to the second set of questions addressed in this review: How does the interspersal procedure work? What is the mechanism responsible for the effects of the interspersal procedure? What are the key variables in the procedure that would influence the efficacy of the procedure?

In an effort to study the mechanism responsible for the effects of the interspersal intervention, researchers investigated factors associated with procedures and their effects on choice of materials. For example, Skinner et al. (1996b, 1999, 1996c) investigated characteristics of interspersed tasks, Cates and Dalenberg (2005) and Cates and Erkfritz
(2007) investigated ratios of additional tasks on the assignments, and Billington et al. (2004a, 2004b) studied interactive effects of task interspersal and assignment complexity.

Characteristics of interspersed items. Skinner et al., (1996b, 1996c Experiment 2) investigated the effects of interspersed procedures by varying the brevity of the interspersed tasks. They used worksheets containing 16 three-digit by two-digit multiplication (3 x 2) tasks as the control assignment. Experimental assignments contained the same type and number of the target tasks (16, 3 x 2 problems), plus six additional interspersed tasks. Skinner et al., (1996a) embedded six (a) two-digit divided by one-digit problems with one-digit whole number correct solutions (e.g., 64 / 8 = ___) and (b) four-digit plus four-digit problems with carrying required at each step (e.g., 7845 + 6759 = ___). In the other study, Skinner et al. (1996c Experiment 2) added six (a) three-digit divided by two-digit problems (e.g., 365 / 21 = ___), and (b) one-digit by one-digit multiplication (1 x 1) problems. In the study, a sequence of three target tasks (3 x 2 problems) preceded each 1 x 1 problem on the experimental worksheets.

Researchers asked college students to work on the control and two experimental worksheets containing different types of interspersed tasks for 305 seconds. Both control and experimental worksheets contained more tasks than the students could complete. At the end of the time limit, researchers asked the students to choose an additional assignment to complete. Results from both of the studies showed that experimental worksheets interspersed with brief tasks (i.e., 2 / 1 and 1 x 1) had the highest number of total tasks completed. Students also chose worksheets interspersed with brief tasks as the most preferred assignment. In addition, researchers did not find a significant difference between (a) the number of total problems completed and (b) student choice of the
material on control worksheets and worksheets containing easy tasks (i.e., $4 + 4$ and $3 / 2$). Therefore, Skinner et al. suggested that it was the relative brevity rather than reduced difficulty of the embedded tasks to the target tasks that influenced student choice of the materials. Researchers recommended that tasks that take relatively less time to complete should be used as interspersed items in the procedure.

Skinner et al. (1999) further demonstrated the functional relationship between relative brevity of interspersed tasks and choice of material by increasing the complexity of the target tasks while holding the brief tasks constant. In the study, Skinner et al. asked 94 college students to work on four pairs of assignments. Each academic assignment pair contained a control worksheet and an experimental worksheet. The control worksheet had 18 target multiplication tasks. The target multiplication tasks in each assignment pair were four-digit by one-digit ($4 \times 1$), four-digit by two-digit ($4 \times 2$), four-digit by three-digit ($4 \times 3$) and four-digit by four-digit ($4 \times 4$). The interspersal worksheets were developed by adding six additional one-digit by one-digit multiplication ($1 \times 1$) tasks to the individual control worksheet, every $1 \times 1$ task followed by a series of three target tasks. Students were asked to work on both control and experimental worksheets in a pair for 255 seconds. After they worked on two types of worksheets in the same assignment pair, the researchers asked the students to choose a worksheet (either control or interspersal) as a homework assignment. The procedure was repeated until the students were exposed to all four assignment pairs. Skinner et al. found that within individual assignment pairs students completed more total problems (both target and interspersed tasks) on the interspersal worksheets and significantly more students chose interspersal worksheets as the homework assignment. Furthermore, Skinner et al. compared students’
task completion and choice across the four assignment pairs and found that as the relative rate of problem completion on the interspersal worksheets increased (rate of total problem completion on the interspersal worksheets divided by rate of problem completion on the control worksheets), the number of students who chose interspersal worksheets increased as well and concluded that it was the relative rate of task completion that influenced student choice of materials.

**Ratio of the interspersed items.** Cates and Dalenberg (2005) and Cates and Erkfritz (2007) investigated effects of different ratios of interspersed tasks on student choice of materials. Both Cates and Dalenberg and Cates and Erkfritz developed four pairs of assignments. Each assignment pair contained one control worksheet and one experimental worksheet. Control and experimental worksheets in an assignment pair contained the same number and type of target tasks, 15 three-digit by two-digit multiplication (3 x 2) problems. Researchers implemented the interspersal procedure by embedding additional one-digit by one-digit multiplication (1 x 1) problems in each experimental worksheet. The 1 x 1 problems were interspersed at three different ratios across assignment pairs: every fifth, every third, and every other problem. In other words, each experimental worksheet in the four assignment pairs contained 3, 5, and 15 additional 1 x 1 tasks. Each worksheet contained more problems than the students could finish within the time limit. After the college students spent 3 min (Cates & Dalenberg, 2005) and middle school students spent 4 min (Cates & Erkfritz, 2007) working on the control and experimental worksheets in the same assignment pair, the researchers asked the students to choose one type of worksheet as a homework assignment. This procedure was repeated until students were exposed to all three pairs of assignments. The results
from both of the studies indicate that within individual assignment pairs, students completed more total problems (both target and additional problems) on the interspersal worksheets. In addition, Cates and Dalenberg found significantly more students chose interspersal worksheets with all three ratios. Similarly, Cates and Erkfritz found significantly more students chose the interspersal worksheets when the additional 1 x 1 tasks were interspersed at a rate of every third and every other problem (i.e., interspersed task to target task at 1:3 and 1:1 ratio). However, students in the study did not choose the experimental worksheets more often when 1 x 1 tasks were followed by a series of five target 3 x 2 tasks (interspersed to target task ratio of 1:5). Both studies confirmed that the proportion of students who chose the interspersal worksheets increased as more brief tasks were added to the worksheets. Researchers suggested that there was a functional relationship between the density of the interspersed tasks and students’ choice of the worksheets.

**Interspersal and Matching**

The review of the task interspersal literature indicates that task interspersal increases the likelihood that students will choose academic materials that enhance the rate of total task completion on the worksheets. The relationship between student choice of worksheets and the relative rate of task completion on the worksheets can be described by the discrete task completion hypothesis (Skinner, 2002) and Herrnstein’s matching law (1961).

**Discrete Task Completion Hypothesis**

Skinner (2002) posited that most learners have a learning history in which consequences are delivered contingent upon assignment completion. Thus, assignment
completion leads to opportunities to gain reinforcers (e.g., verbal praise, extra computer
time). Alternatively, assignment completion may also lead to avoidance of aversive
stimuli (e.g., after students complete assignments they don’t have to stay in the classroom
during recess). Pairing assignment completion with both positive and negative
reinforcement makes academic assignment completion a conditioned reinforcing stimulus
(Sulzer-Azaroff & Mayer, 1986). The completion of individual tasks within the
assignment leads to the successful completion of the whole assignment, which eventually
leads to the attainment of the reinforcer. Each completed individual task thus serves as a
reinforcing stimulus (Skinner, 2002). Therefore, the speed at which a student completes a
given assignment (rate of completion) equals the rate of reinforcement. In other words,
the more tasks a student can complete per unit of time the higher the density of
reinforcement. Review of the interspersal intervention reveals that effective
implementation results in higher rates of total task completion (target and interspersed
tasks) on the experimental worksheets. Thus, students acquire more reinforcers from the
interspersal worksheets than control worksheets. The discrepancy of the rate of
reinforcement generated by the two types of worksheets leads to consistent selection of
the worksheets that result in higher levels of reinforcement. The effects of this relative
rate of reinforcement on choice behavior can be explained by Herrnstein’s matching law
(1961).

_Herrnstein’s Matching Law_

Herrnstein hypothesized that organisms are constantly presented with choices and
the selection of any one alternative is determined by the relative rates of reinforcement
among those choices. More specifically, Herrnstein found that the relative frequency of
responding for a given alternative approximately equaled, or “matched”, the relative reinforcement frequencies for that alternative. This relationship may be algebraically summarized in Equation 1:

\[
\frac{R_1}{R_1 + R_2} = \frac{r_1}{r_1 + r_2}
\]

where \( R_1 \) represents response rate for alternative 1 and \( R_2 \) denotes response rate for alternative 2, \( r_1 \) denotes reinforcement frequency 1 and \( r_2 \) stands for reinforcement frequency 2.

Researchers have shown that organisms distribute responses in the same proportion that reinforcers are distributed among alternatives (Davison & McCarthy, 1988), thus providing consistent support for matching law. Herrnstein’s matching law has also proven to be an effective framework for exploring factors affecting student choice and identifying underlying mechanisms that influence choice behavior (Billington & DiTommaso, 2003). Researchers have used the matching law to investigate student choice behavior and develop strategies and procedures to increase the probability that students will choose to complete academic assignments (e.g., Lee & Zentall, 2006; Martens & Houk, 1989; Martens, Lochner, & Kelly, 1992).

Matching Analysis

Applied to student choice of academic material, the matching equation suggests that if twice as much reinforcement is delivered through working on one type of assignment, students are twice as likely to choose to work on that particular type of assignment. More specifically, based on the discrete task completion hypothesis if students can complete the interspersal worksheets twice as fast as the control worksheets,
they are much more likely to chose the interspersal worksheets. Therefore the interspersal procedure influences student selection of the academic material by varying the relative rate of problem completion and subsequent density of reinforcement from the worksheets.

Similar to the confirmation of matching equation in basic research (e.g., Herrnstein, 1961), interspersal researchers focused on students’ choice behaviors in controlled environments where students were presented with only two alternatives (i.e., traditional worksheet and interspersed worksheet). When the rates of reinforcement for the two alternatives were known (i.e., the rate of discrete task completion from each type of worksheet) interspersal researchers could quantitatively investigate the probability of student choice of either type of worksheet using the matching equation. Skinner (2002) and Billington and Skinner (2006) quantitatively analyzed the published interspersal studies using the matching equation. They found that the relative rates of task completion derived from the two types of worksheets accounted for 97% (Skinner, 2002) and 93% (Billington & Skinner, 2002) of the variance of student choice of the materials. This functional relationship between the relative task completion and student choice has been confirmed by an additional three studies (Cates & Dalenberg, 2005; Cates & Erkfritz, 2007; Skinner et al., 1999). Evidenced in the studies, as the relative problem completion rate of one assignment was enhanced, the probability of student choice of one assignment over the other was increased as well.

On the other hand, this functional relationship is also demonstrated by research that did not lead to student choice of the interspersal worksheets when (a) embedded tasks required more time to complete (Skinner et al., 1996b; Skinner et al., 1996c Experiment 2), (b) the assignment was continuous and did not contain multiple discrete
tasks (Martin et al., 2001), or (c) there were not enough brief tasks interspersed (Cates & Erkfritz, 2007). When easy tasks that required too much time to complete (e.g., 4 x 4 and 3 / 2 problems) were added to the worksheets, students could not complete more total problems on the interspersal worksheets within same amount of time as the control worksheet (Skinner et al., 1996b; Skinner et al., 1996c Experiment 2). Thus the discrepancy between the rate of reinforcement on the control and experimental worksheets was not large enough for students to demonstrate a preference for either of the worksheets.

Similarly, Martin et al. (2001) found that when lower grade level shorter paragraphs were interspersed to the continuous passage reading assignment, students did not choose the interspersed reading passage more often than the traditional assignment. Students read more paragraphs under the experimental condition, but took a longer time to finish reading the passage. Their rate of task completion was not enhanced because the whole story reading was a continuous assignment (i.e., no discrete parts). In other words, across control and experimental conditions students finished reading only one passage. As predicted by matching law, students did not choose one type of material over the other because the rates of reinforcement derived from the two assignments were equivalent.

The effectiveness of the interspersal procedure is also affected by the quantity of the brief tasks interspersed on the worksheets. The majority of the included interspersal research used 1:3 brief to target task ratio (i.e., every brief task was preceded/followed by a sequence of three target tasks). When Cates and Erkfritz (2007) implemented the procedure using a thinner ratio (1:5) students did not prefer the interspersed worksheets more than control worksheets although students completed more total problems on the
interspersal worksheets. It is plausible that the incremental increase of the total tasks completed on the experimental worksheets was not large enough to influence student choice. Therefore, what appears to be unsuccessful implementation of the interspersal procedures in these studies could be all caused by insufficient increase of relative rate of completion on the interspersal worksheets, providing additional evidence for the discrete task completion hypothesis and matching equation.

Limitations of the Research

Academic materials are among the most salient stimuli in the classroom (Dunlap & Kern, 1996). As a task modification procedure, task interspersal increases the likelihood of student choice of academic materials over other alternatives. Consequently, interspersal increases opportunities to respond to tasks. In addition, interspersal interventions are time and resource efficient (Billington et al., 2004a; McCurdy et al., 2001). However, this review revealed several shortcomings in the current interspersal literature that are related to confounding methodology and implication for research and practice.

Task Condition

Similar to confirmation of the matching equation in the laboratory, researchers of the included studies only changed the rate of reinforcement derived from the interspersal worksheets, while assuming response effort and dimensions of reinforcers were constant. One response effort control procedure used by almost all interspersal researchers was requiring students to work on both types of worksheets for an equal amount of time (i.e., time-constant condition). Alternatively, Martin et al. (1991) and Robinson and Skinner (2002 Experiment 2) used a task constant condition to equate the response effort (i.e.,
requiring students to complete equal number of target tasks on both types of worksheets). Studies that investigated the interspersal procedures under time- and task-constant conditions yielded conflicting results, indicating task condition and interspersal procedures may have interactively affected student choice of materials.

**Time constant condition.** Results from all of the reviewed studies that employed time-constant conditions indicate that students completed more target problems on the control worksheets. Researchers in four studies also found that this difference was statistically significant (Skinner et al., 1996b Experiment 1; Skinner et al., 1996c; Wildmon et al., 1999; Wildmon et al., 1998). Results showed an increase in the rate of total problems completed was not enough to make up for the additional time required for students to complete the interspersed problems. In other words, students would need more time to complete all the problems (both target and interspersed tasks) on the interspersal worksheets. Using a time-constant experimental condition may have inadvertently limited student opportunities to respond to the target problems because interspersal researchers may have inadvertently reduced task demands on interspersal worksheets.

**Task-constant condition.** Two of the included studies (Martin et al., 2001; Robinson & Skinner, 2002 Experiment 2) required the students to finish control and interspersal assignments without a time limit. Researchers found that student rate of completion on the assignments were not different. As a result, students in both of the studies did not show preference for either of the assignments. This result has been replicated in other three related studies (Clark & Rhymer, 2003; Rhymer & Cates, 2006; Rhymer & Morgan, 2005). Rhymer and Cates illustrated the relationship between total
problem completion and time under task-constant condition. When required to complete both control and experimental assignments, students completed more total problems on the interspersal worksheets. However, increased total problem completion was attenuated by the extra time required to complete the interspersal assignment. Consequently, the students did not have a preference for either of the assignments. It is consistent with the discrete task completion hypothesis and the matching equation that students would not choose the interspersed assignments when there were no differences between the rate of problem completion.

Direct comparison of the two conditions. Researchers in two of the related studies directly compared student choice under the time- and task-constant conditions (Billington & Skinner, 2002; Meadows & Skinner, 2005). Billington and Skinner (2002) investigated the strength of an interspersal intervention by including 20% more target tasks on the interspersal worksheets. College students chose interspersal worksheets that contained more total problems when they did not have to complete the worksheets (time constant condition). Under the task constant condition, after students finished both types of worksheets students did not show any preference for either of the materials. On the other hand, Meadows and Skinner’s investigation conflicts with this finding. They found that students chose interspersal worksheets consistently during the time- and task-constant condition. However, sequence effects may have confounded both of the studies because the participants were all exposed to the time-constant condition first. Practical Implications

Using only a time-based contingencies may not accurately reflect the real contingencies in applied settings. In typical classrooms, teachers generally use a mix of
time-based (e.g., “Work on this assignment for 10 minutes.”) and task-based (e.g., “Finish these 10 problems.”) contingencies. One typical task based contingency is a homework assignment because completion of a homework assignment is based on the number of tasks the student is required to finish. Almost all of the included studies used a choice of homework as an indication of student preference of the task format. However, the condition students were exposed to in the experiments (time contingency) were not identical to what was used in the preference assessment (task contingency). Therefore preference assessment results may not accurately reflect the choice students may make in the task completion condition. It is important for researchers to investigate the interactive effects of interspersal procedure and working condition.

**Repeated Measurement**

Asking students to choose a type of worksheet as a homework assignment was the preference assessment used in the included experiments. Students in a majority of the studies had only one such opportunity to choose. Nevertheless, McDonald and Ardoin (2007) had students work on four pairs of control and interspersal worksheets. After exposure to each pair, the students had the opportunity to choose a task format. McDonald and Ardoin reported that students consistently chose interspersal worksheets in the four observations. However, some other interspersal investigations that did not meet the inclusion criteria indicated that when students had repeated exposure to the interspersal worksheets and opportunities to choose, their choice of materials fluctuated (Clark & Rhymer, 2003) and the effects of the interspersal procedure diminished (McCurdy et al., 2001; Skinner et al., 2002). Therefore, it is important for future researchers to investigate student choice of materials using time-series design. More
specifically, researchers need to study the durability of the interspersal effects when students had multiple opportunities to choose after repeated exposures to both types of the assignments.

External Validity

Researchers recruited college students and students receiving general education in elementary and high schools for most of the interspersal studies. While use of college and general education students was an important first step, we must move on to examine interspersal procedures with other populations. Rhymer and Morgan (2005) and Rhymer and Cates (2006) found that college students and elementary school age students responded differently to interspersal interventions. Other researchers (Neef & Lutz, 2001a; Pierce, 1998) have also suggested that sensitivities to reinforcer dimension (i.e., reinforcer quality, immediacy) and task demand (response effort) may vary across individuals and context, particularly for students with learning problems. This particular population tends to have a different learning history in which reinforcement contingent upon assignment completion is infrequent (Teeple & Skinner, 2004). This phenomenon may further affect the effectiveness of the discrete task completion hypothesis in that discrete task completion may not serve as conditioned reinforcer for these students who do not have a history of success in school. In this review, only three included studies investigated interspersal interventions on students with learning problems including learning disabilities (Wildmon et al., 2004), emotional and behavioral disorders (Teeple & Skinner, 2004), and students at risk for academic failure (Robinson & Skinner, 2002). Given the benefits and application of the interspersal procedure in special education,
further investigations are warranted to generalize the findings in the literature to students with various learning problems.

The interspersal research in which college students participated also lack task ecological validity because college students were asked to complete mathematics problems similar to the curriculum of elementary age students (Rhymer & Morgan, 2005). Researchers in eight of the included studies (Cates & Erkfrtiz, 2007; Logan & Skinner, 1998; Martin et al., 2001; McDonald & Ardoin, 2007; Robinson & Skinner, 2002; Teeple & Skinner, 2004; Wildmon et al., 1999; Wildmon et al., 2004) used tasks that were being learned by the participants and served as part of the school curriculum objectives. The length of the assignments ranged from 4 to 15 min. Assignments in these studies provided additional practice opportunities for the students to reach fluency. Using academic tasks that are course relevant and grade contingent can also enhance external and educational validity of the findings (Billington & Skinner, 2002). Future researchers need to continue investigating the effects of interspersal procedure on course relevant tasks that are part of the curriculum used in the classrooms (e.g., Billington & Skinner, 2002; Skinner et al., 1999; Skinner et al., 1996c). In addition, the number of items on the assignment should be more typical with respect to the length of the assignment (Meadows & Skinner, 2005).

**Research Questions**

This review of the literature revealed that interspersal research has several limitations related to task condition, research methods and external validity. To extend this line of research, I examined the relationship between student choice and assignment contingencies for students with learning problems using concurrent schedule and reversal design. I sought to answer the following research questions:
1. What are the effects of the interspersal procedure on student choice of task material under task- and time-constant conditions?

2. What are the effects of task- and time-based contingencies on student rate of task completion?
CHAPTER 3

Method

Participants and Setting

Al, Mig and Mar were three fourth grade students who participated in the study. Al and Mig were 10-year-old Hispanic males. Mar was a 10-year-old African American male. All three students were identified as students with learning disabilities. The teacher reported that the three students needed additional help in mathematics computation. Each student attended a resource room for reading and mathematics in a public school located in a large urban district in Southeastern Pennsylvania. Classroom staff included one part-time paraeducator and one special education teacher. The experiment was conducted in the back of the classroom (in an area approximately 5 m x 10 m).

Materials

I administered a curriculum based measurement (CBM) before the study to determine the type of math problems to include on the interspersal and traditional worksheets. Researchers and practitioners found that CBM provides an efficient measurement of students’ learning stages and growth in skills (Calhoon & Fuchs, 2003; Deno, 1985). During an initial assessment, the teacher asked the students to work on two probes for 1-min. One probe consisted of three-digit by three-digit addition (3 x 3) with two regroupings computation problems and other contained one-digit by one-digit addition (1 x 1) computation problems. All probes were printed on white paper (21.5 cm x 28 cm) and contained more problems than the students could complete in the allotted 1-min. Table 1 presents rate and accuracy of task completion from the initial assessment across the three students. Assessment results suggested that Al and Mig completed three-
digit by three-digit addition (3 x 3) problems with two regroupings at 6.60 and 6.40 digits correct per minute (DCPM) respectively. Mar completed similar tasks with a higher rate of completion of 12.20 digits correct per minute. All of the students completed the tasks with a minimum accuracy of 80%. CBM results indicated that all three students’ 3 x 3 computation skills were at instructional level characterized by low rate of completion with high degree of accuracy (Lovitt, 1978). Therefore, I chose 3 x 3 tasks with two regroupings as target tasks on both traditional and interspersal worksheets for all the participants. Initial CBM also indicated that both Al and Mig completed one-digit by one-digit addition (1 x 1) computation problems at 17 digits correct per minute. Mar completed similar 1 x 1 problems at 38 digits correct per minute. All three students completed the tasks with 100% accuracy. Their 1 x 1 digit addition computation skills were below the recommended fluency level (Salvia & Hughes, 1990). Based on task brevity and student fluency level relative to the target 3 x 3 tasks (Skinner, 2002), I chose 1 x 1 computation problems as the additional tasks on the interspersal worksheets.

Table 1. Total digits completed correctly per minute and accuracy on initial assessment across the three students.
Tasks were presented in horizontal rows on the worksheets (21.5 cm x 28 cm); each row contained four problems. Two types of worksheets were developed for the study. *Traditional* worksheets contained only target problems (i.e., 3 x 3 tasks with two regroupings). *Interspersed* worksheets were similar to the traditional worksheets with the exception that a sequence of three 1 x 1 problems preceded each target problem. Compared to the traditional interspersal procedure, we used a higher brief to targets task ratio in the study to enhance the discrepancy of the density of reinforcement across types of worksheets. Each problem was generated with Microsoft Excel® using random number generation function.

*Procedures*

Students worked on packets of traditional and interspersal worksheets under time- and task-constant conditions. To facilitate student’s discrimination of experimental conditions, I added clock faces at the top of each page of the worksheets during time-
constant condition and stop signs at the bottom of the last page of the worksheets during task-constant condition.

*Time constant condition.* In this condition the time given to complete the assignment was held constant. Students worked on both interspersal and traditional worksheets for 5 min each. Packets of materials contained more problems than the students could finish in each 5-min session. The teacher placed a packet of worksheets directly in front of the student and said, “Here is the task you need to work on for five minutes. Please work horizontally from left to right without skipping any problems and work as fast and accurately as you can.” At the end of 5 min, the teacher asked the students to stop working.

*Task constant condition.* In this condition, traditional and interspersal worksheets contained an equal number of target tasks. The task constant condition was similar to the time constant condition except that the teacher told the student, “Here’s the task you need to work on. You may stop when you finish all the tasks on the worksheet. Please work horizontally from left to right without skipping any problems and work as fast and accurately as you can.”

Within each experimental condition, the order of the worksheets was counterbalanced. At the conclusion of each session the researcher read the following instructions, “You have just finished two packets of worksheets. Which one would you like to work on next?” Students were then asked to complete their chosen assignment. The location of the worksheets was counterbalanced. The traditional, interspersal, and choice procedures were administered in two experimental conditions.
Based on initial CBM data, we equated the worksheet packet length during the time and task constant conditions to keep time to completion approximately same. We gave Al and Mig a traditional worksheet containing 12 target problems (i.e., three rows of 4 problems) during the task constant conditions. The interspersal worksheets for both students contained similar 12 target problems with 36 additional 1 x 1 problems. Mar’s traditional worksheet during task-constant condition contained 20 target problems (i.e., five rows of 4 problems). His interspersal worksheets had 20 target tasks plus 60, 1 x 1 problems.

**Experimental Design and Dependent Variables**

A concurrent-schedule design with a reversal component (Mace et al., 1990) was used to compare students’ choice of worksheets under different task contingencies. Each experimental condition had five sessions. Al and Mig participated in the time-constant condition first followed by the task-constant condition. Mar participated in the task-constant condition first followed by the time-constant condition. A concurrent-schedule design allowed researchers to study whether and why an individual chose one response over the other alternatives at a given point in time (Fisher & Mazur, 1997). The two types of worksheets were simultaneously available to the students and dimensions of the reinforcers (schedule, effort and quality) associated with each type of worksheet were varied under the two task contingencies. Thus, researchers could identify the influence of each dimension of the reinforcers on student preference through how much responding is allocated to one type of worksheets relative to the other under different contingencies. The internal validity of the results is strengthened when the reversal design replicates the
effects with the same subject i.e., the last two conditions replicate the first two conditions (Tawney & Gast, 1984).

Two sets of dependent measures were collected. First, I recorded student choice of the worksheets. Student selection of a worksheet is defined as student pointing to and then completing a given worksheet. Second, I documented their DCPM on the worksheets. DCPM is scored as number of correct digits completed divided by time spent working on math worksheets.

*Procedure Integrity and Interrater Reliability*

I used a procedural checklist to ensure treatment integrity during all sessions (see Appendix C). Based on a brief task analysis, the procedural checklist consists of 14 steps (e.g., read the directions, counterbalance the order and location of the worksheets in each session). The checklist was validated by two behavioral researchers with expertise in interspersal research. One independent observer observed 25% of the sessions and completed the procedural checklist. Treatment integrity was calculated by dividing the number of steps completed by the total number of steps and multiplying by 100. Procedural integrity was 100% across sessions.

Similarly, an independent observer conducted interobserver agreement checks during 25% of the sessions. The independent observer recorded student choice of worksheets and counted the number of digits completed correctly and incorrectly. Point-by-point agreement was calculated by dividing agreement by agreement plus disagreement multiplied by 100. Interrater reliability for student selection of the materials and DCPM was 100%.
CHAPTER 4

Results

In this chapter, results are presented for each student across task format and then across task conditions. Findings are summarized briefly based on the research questions posed in the study.

Student Choice of Materials

Figure 1 presents student selection of materials between the traditional and interspersal worksheets under time- and task-constant conditions rates of digits completed correctly per minute on the chosen worksheets by individual students.

Individual Results

Al. During the initial time-constant condition, Al chose interspersal worksheets 100% of the time. During a replication phase of the same condition he chose the interspersal worksheets only 40% of the time, below the 80% preference criterion suggested in the preference literature (e.g., Pace, Ivancic, Edwards, Iwata, & Page, 1985). Al’s choice of materials was less ambiguous during the task constant conditions. He chose traditional worksheets 100% and 80% of the time during his initial and replication phase of the task-constant condition respectively. In general, Al preferred traditional worksheets during the task-constant condition. His choice during the time-constant conditions did not show a clear preference for either set of materials.

Mig. During the initial time-constant condition, Mig chose traditional worksheets 80% of the time. However, he chose interspersal worksheets 80% of the time during the replication phase of the same condition. Mig’s preference was more obvious during the task constant condition. He chose traditional worksheets 100% of the time during both of
the task-constant conditions. In general, Mig preferred traditional worksheets during the task-constant condition. However, he did not express a clear preference for either set of materials during the time-constant condition.

*Mar.* Mar chose the interspersal worksheets 100% of the time during the time-constant condition. Similarly, during the task-constant condition Mar chose traditional worksheets 100% of the time. Thus, Mar preferred interspersal worksheets during the time-constant condition and traditional worksheets during the task-constant condition.

*Figure 1.* Number of digits completed correctly per minute on the chosen task format during time- and task-constant conditions.
Assignment Completion

Table 2 through 4 presents student rate of completion during time- and task-constant condition when the materials were assigned by the teacher.

Individual Results

Al. Table 2 presents Al’s digits correct per minute (DCPM) on teacher assigned traditional and interspersal worksheets under time- and task-constant conditions. In comparison to the time-constant condition, Al completed 57% more DCPM on the traditional worksheets and 33% more DCPM on the interspersal worksheets during task-constant condition. Working under the same condition, his DCPM on the interspersal worksheets was 55% higher than the traditional worksheets. During the task-constant condition, he spent an average of 41% more time working on the interspersal worksheets than the traditional worksheets.

Table 2. Al’s mean (SD) rate of task completion and time in seconds on traditional and interspersal worksheets during time- and task-constant conditions.
### Table 3

<table>
<thead>
<tr>
<th>Experimental condition</th>
<th>Traditional</th>
<th>Interspersal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DCPM (SD)</td>
<td>Time</td>
</tr>
<tr>
<td>Time constant</td>
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<td></td>
</tr>
<tr>
<td>Initial</td>
<td>3.92 (1.12)</td>
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<tr>
<td>Replication</td>
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<td>Task constant</td>
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<td>Initial</td>
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</tr>
<tr>
<td>Replication</td>
<td>7.09 (3.06)</td>
<td>253</td>
</tr>
</tbody>
</table>

_Mig._ Table 3 presents Mig’s DCPM on teacher assigned traditional and interspersal worksheets under time- and task-constant conditions. Relative to the time-constant condition, Mig increased his DCPM on both traditional and interspersal worksheets by 36% and 6% respectively during task-constant condition. Across the experimental conditions, Mig had higher DCPM on interspersal worksheets. He completed 25% more digits correctly per minute on the interspersal worksheets than traditional worksheets. Mig spent an average of 42% more time working on the interspersal worksheets than the traditional worksheets during the task constant condition.

_Table 3. Mig’s mean (SD) rate of task completion and time in seconds on traditional and interspersal worksheets during time- and task-constant conditions._
Table 4 presents Mar’s DCPM on teacher assigned traditional and interspersal worksheets under time- and task-constant conditions. During time-constant condition, Mar completed 7% more DCPM on the traditional worksheets and 5% more DCPM on the interspersal worksheets than the task-constant condition. Mig’s DCPM on the interspersal worksheets was higher than the traditional worksheets. His DCPM on the interspersal worksheets was 37% higher than the traditional worksheets. During the task-constant condition, he spent an average of 40% more time working on the interspersal worksheets than the traditional worksheets.

<table>
<thead>
<tr>
<th></th>
<th>Traditional</th>
<th>Interspersal</th>
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<tr>
<td>Experimental condition</td>
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<td>Time</td>
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<tr>
<td>Time constant</td>
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<td>8.96 (2.59)</td>
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<td>Replication</td>
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</table>

*Mar.* Table 4 presents Mar’s DCPM on teacher assigned traditional and interspersal worksheets under time- and task-constant conditions. During time-constant condition, Mar completed 7% more DCPM on the traditional worksheets and 5% more DCPM on the interspersal worksheets than the task-constant condition. Mig’s DCPM on the interspersal worksheets was higher than the traditional worksheets. His DCPM on the interspersal worksheets was 37% higher than the traditional worksheets. During the task-constant condition, he spent an average of 40% more time working on the interspersal worksheets than the traditional worksheets.

Table 4. *Mar’s mean (SD) rate of task completion and time in seconds on traditional and interspersal worksheets during time- and task-constant conditions.*
<table>
<thead>
<tr>
<th>Experimental condition</th>
<th>Traditional DCPM ($SD$)</th>
<th>Time</th>
<th>Interspersal DCPM ($SD$)</th>
<th>Time</th>
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<td><strong>Time constant</strong></td>
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<td></td>
<td></td>
<td></td>
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<tr>
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<td>13.28 (2.70)</td>
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<td><strong>Task constant</strong></td>
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<td></td>
</tr>
<tr>
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<td>16.81 (3.80)</td>
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</table>

*Summary of Results*

Overall, the results showed that during the task-constant condition all three students had the same clear preference for the traditional worksheets. However, their preferences of task material during the time-constant condition were individualized. Across the two conditions, students had higher DCPM on the interspersal worksheets. They completed interspersal worksheets with an average of 40% more DCPM than the traditional worksheets. In comparison to the time required to complete the traditional worksheets during the task-constant condition, students needed an average of 37% more time to finish the interspersal worksheets. In addition, two of the students (Al and Mig) had higher DCPM during the task-constant condition regardless of the task format.
However, one student (Mar) had higher DCPM on both types of worksheets during the time-constant condition.
CHAPTER 5

Discussion

Two research questions were posed in this study. First, what are the effects of the interspersal procedure on student selection of task material under task- and time-constant conditions? Second, what are the effects of task condition on the rate of academic assignment completions? The results of the study show that academic assignments and task contingencies can interactively influence student choice of material and rate of responding. All three students preferred traditional worksheets during the task-constant condition. However, during the time-constant condition students’ preferences of task material varied, thus indicating that task contingencies may have influenced student academic responding. Two of the students had higher rates of task completion during the task-constant condition. One student’s rate of completion was higher during the time-constant condition. In this chapter, the relationship between student selection of worksheets and task completion is analyzed within the context of discrete task completion hypothesis (Skinner, 2002) and Herrnstein’s matching law (1961). The analysis also includes limitations and directions for future research. Finally, implications for practitioners are provided and conclusions are drawn.

Choice of Material and Task Condition

The primary purpose of this study was to examine students’ allocation of responding across traditional and interspersal worksheets under time- and task-based contingencies. Overall results of the study were consistent with previous investigations indicating that each student was differentially affected by the reinforcer dimensions (i.e., quantity, effort, quality, valence and immediacy), confirming the assertion that individual
response patterns are likely to be affected, not only by the schedule of reinforcement as predicted by the matching law and discrete task completion hypothesis, but also by different dimensions of the reinforcer (Cuvo, Lerch, Leurquin, Gaffaney, & Poppen, 1998; Neef & Lutz, 2001a; Neef et al., 1992; Neef, Shade, & Miller, 1994). Therefore, I restricted data analysis to the qualitative description of the choice pattern because it may be premature to invoke a literal translation of matching law to the current data when precise influence of these variables on matching is still unknown (Mace, 1994).

**Choice-Making During Task-Constant Condition.**

During the task-constant condition, students were asked to finish all the tasks on the traditional and interspersal worksheets. Each worksheet contained 12 target three-digit by three-digit addition (3 x 3) problems. Interspersal worksheets contained 36 additional one-digit by one-digit addition (1 x 1) tasks. In comparison to the traditional worksheets, the additional 1 x 1 digit tasks increased students’ rate of total task completion on the interspersal worksheets by 41%. Thus, the relatively higher rate of total task completion on the interspersal worksheets provided a higher density of reinforcement than traditional worksheets. With the increase in density of reinforcement, came an increase in response effort. The interspersal worksheets required an average of 37% more time for students to complete. The three students in this study chose traditional worksheets 97% of the time when the task was held constant, suggesting that response effort outweighed increase in the density of reinforcement. Therefore, the balance was tipped away from the schedule of reinforcement to response effort, which became a more salient variable affecting student selection of the material under the task-based contingency at this level of effort and contingency. This finding is consistent with
previous research investigating the relative saliency of the dimensions of reinforcers in applied settings. Researchers found that reinforcer parameters such as response effort may override the schedule of reinforcement (e.g., Cuvo et al., 1998; Neef, Bicard, & Endo, 2001; Neef & Lutz, 2001a, 2001b; Neef et al., 1993; Neef et al., 1992; Neef et al., 1994). For example, Cuvo et al. found that kindergarten students chose an activity that required less effort (e.g., jump over a lower bar) more frequently when reinforcement schedules were equal. Students’ choices showed greater variation when researchers thinned the schedule of reinforcement associated with lower bar jumping. One student consistently chose to jump over the lower bar with thinner schedule of reinforcement across the three sessions. Cuvo et al. suggested that increases in response effort decreased the likelihood of obtaining the reinforcer because successful completion of the task became less likely. In addition, a response that requires more effort may also take longer to complete, thus delaying delivery of reinforcers. Similarly, in the present study despite its relatively thin schedule of reinforcement, the three students chose the traditional assignments more frequently because it required less response effort during the task-constant condition.

*Choice-Making During Time-Constant Condition.*

During the time-constant condition, termination of assignment was based on the amount of time elapsed. Students were asked to work on both traditional and interspersal worksheets for 300 seconds. Similar to the task-constant condition, interspersal worksheets increased the students’ rate of total task completion by 47% relative to the traditional worksheets without requiring students to spend extra time on the assignment. However, the higher density reinforcement associated with the interspersal worksheets
did not result in a consistent choice of the interspersal worksheets across the three students. Only one student (Mar) chose interspersal worksheets consistently during the initial and replication phases of the time-constant conditions. His choice pattern during the time-constant condition replicated the findings in the current interspersal research literature, confirming the discrete task completion hypothesis and the matching law that individuals allocate their responses in proportion to density of reinforcement (Fisher & Mazur, 1997).

Choices of the other two students were individualized. During the initial and replication phase of the time-constant conditions, both Mig and Al had higher rates of total task completion on the interspersal worksheets. However, Al preferred the interspersal worksheets during the initial time-constant phase, but failed to express the same preference during the replication phase. Mig, on the other hand, preferred traditional worksheets during the initial phase and interspersal worksheets during the replication phase. Inconsistent choice patterns of the worksheets indicated that there are factors other than density of reinforcement that may have affected Al and Mig’s choice making.

One potential cause of deviation from the choice pattern predicted by the discrete task completion hypothesis and matching law was that the two students were insensitive to the schedules of reinforcement associated with the two types of worksheets in the study. For example, Neef et al. (1992) reported undermatching in two participants, evidenced by choosing an alternative with richer schedules of reinforcement less frequently than predicted by the matching law. They found that undermatching was related to the students’ inability to discriminate the features of reinforcement schedules.
After the researchers added a series of adjunct procedures (e.g., audio cue and experimenter demonstration) to facilitate discrimination both students allocated their responses as predicted by the relative density of reinforcement. Therefore matching was observed most frequently when subjects were provided with either visual cues and/or verbal instructions indicating the features of the schedule-correlated stimuli and their corresponding reinforcement frequencies (Neef et al., 1992). In the current study, I did not use any adjunct procedure to distinguish the two worksheets other than the different type of tasks and presentation on the worksheets. Both Al and Mig’s failure to consistently choose the worksheets that resulted in higher rate of task completion (i.e., higher rate of reinforcement) may indicate the reinforcement associated with task completion was not salient enough for the two students to discriminate. Depending on learning history, individual students may have different sensitivities to dimensions of reinforcers. Therefore it may be necessary for researchers to institute additional procedures to facilitate discrimination when schedules associated with each concurrent responses are not easily discriminated by the participants (Fisher & Mazur, 1997). For example, future researchers could apprise the students of their task performance on the worksheets before they choose the worksheets or deliver tokens upon individual task completion on the worksheets (e.g., Lannie & Martens, 2004) to enhance the discrimination of the schedules of reinforcement associated with the worksheets.

On the other hand, the need for additional procedures to facilitate contingency discrimination raises questions about the adequacy of the matching law alone to account for natural human choice behavior (Fuqua, 1984). For example, differences in the quality of reinforcers derived from the two types of worksheets may have influenced student
choice in the current study. In applied settings, reinforcers associated with responses are often qualitatively different (e.g., attention from the teacher vs. from peers -- Billington & DiTommaso, 2003). As a result, individuals may distribute their responding in ways that depart from matching (Fisher & Mazur, 1997). For example, Banda, McAfee, Lee and Kubina (2007) observed that some students tended to choose more challenging academic assignments. Banda et al. suggest that completing more difficult tasks on the traditional worksheets may have qualitatively different reinforcing values than worksheets interspersed with brief and easy tasks (e.g., teacher praise for attempting more challenging tasks). Therefore, future researchers need to further investigate student response allocation in applied settings in which dimensions of reinforcers are not the same among different response alternatives.

Task Completion and Task Contingency

Results of the current study suggest that task conditions may also differentially affect students’ task completion. Compared to the time-constant condition, rate of task completion during the task-constant condition for two students (Al and Mig) increased 47% on traditional and 20% on interspersal worksheets respectively. One student (Mar) had an average of 5% decrease of productivity on the two worksheets during the task constant condition. Differential effects of task contingencies on task completion across the students may be a function of preference for different dimensions of reinforcers associated with the two contingencies. Researchers have found that assignment completion is a conditioned reinforcer for learners (Sulzer-Azaroff & Mayer, 1986). During a time-constant condition, assignment completion was contingent upon total amount of time elapsed. In other words, immediacy of the reinforcers was held constant
under this condition. On the other hand, during the task-constant condition students could enhance immediacy of reinforcement by completing the tasks faster because access to conditioned reinforcers (i.e., assignment completion) was contingent upon completion of all the tasks on the worksheets regardless of the time elapsed. Therefore both Al and Mig’s increased productivity during the task-constant condition indicated that their preference was for more immediate delivery of the reinforcers. Likewise, researchers found that sensitivity to immediacy of the reinforcement is individualized. Preference for immediacy of the reinforcement delivery could be a potent variable that dominantly affects student responding (e.g., Neef et al., 1993).

In addition to individual preference for immediacy of the reinforcement, task fluency may have also contributed to the differential reinforcer value associated with assignment completion for the three students. For students with learning problems, academic assignments often act as aversive stimuli (e.g., Doyle, Jenson, Clark, & Gates, 1999) conditioned through failure, insufficient reinforcement (e.g., rarely receiving praise from the teacher), and punishment (e.g., receiving reprimands from teachers and parents). During the task-constant condition, students could terminate of the aversive stimuli from the worksheets occur more quickly by completing tasks at a high rate. Thus, assignment completion may operate like a negative reinforcer. The greater the effort of the response the higher the value of reinforcer it may produce (Cuvo et al., 1998). Compared to both Al and Mig, Mar completed both 3 x 3 and 1 x 1 tasks more fluently, thus with less effort (Binder, 1996). Therefore, negative reinforcement from termination of the assignment may not be as valuable to Mar as to both Al and Mig. However, in the current study I did
not attempt to measure the relative effort associated with task completion across the students, so this explanation remains speculative.

Limitations and Future Research

A number of limitations to this study should be noted. First, results of the study may not generalize to traditional interspersal research. In the current study, students only completed an average of 47% of the target items on the interspersal worksheets during the time-constant condition, suggesting that task interspersal limited student opportunities to respond to the target items under the time-based contingency. However, the ratio of brief tasks to the target tasks on the interspersal worksheets in the current study was higher (3:1) than the ratio used in traditional interspersal studies (1:3). The higher density schedule of reinforcement on the interspersal worksheets used in this study further reduced task complexity over the traditional interspersal studies. Therefore, it will be important to determine if current findings will generalize to traditional task interspersal procedures, in which a lower density schedule of reinforcement is used. In addition, further investigation is warranted to evaluate the discrete task completion hypothesis when both time required to complete the tasks and task complexity are held constant.

Second, the results of the study showed that the students may not be able to discriminate contingencies associated with the conditions, thus obscuring student choice options. For example, during the time-constant condition the students were given more tasks than they could complete in 5 min. However, the teacher noticed that at the beginning of his initial time-constant condition Mig counted pages in each set of worksheets before he made a choice, indicating that the student may not understand the task contingencies. In the current study, we provided verbal instructions at the beginning
of each session and visual cues on the worksheets to remind the students of the task condition. For example, worksheets during the time-constant contingencies had clock faces at the top of each page and task-constant contingencies had stop signs at the bottom of the last page of the worksheets. Future researchers should consider using more explicit instructions such as demonstration and modeling (Mace, Neef, Shade, & Mauro, 1994) and prior instruction and self-explanation (Neef et al., 2004) to make sure that the students understand the task condition before they choose.

Third, I only investigated student discrete choice behavior in which the students were provided access to a single choice between two worksheets that were different in dimensions of the reinforcers. It is important for future researchers to examine the extent to which these preferences translate into actual gains in desirable academic behaviors or productivity. Some researchers find that task interspersal increased on-task behavior for students with learning problems (Calderhead et al., 2006; McCurdy et al., 2001; Skinner et al., 2002). In applied settings when presented with academic work, students generally face more than two choices of behavior: working on the assignments or engaging almost infinite number of other behaviors (e.g., talking to neighbors, leaving the seat, daydreaming, making jokes, writing notes to a friend, drawing pictures, etc). Each response alternative differs in dimensions of reinforcement and response effort. Analogous to the continuous choice behavior, researchers can study student response allocation by measuring proportion amount of time a student engages in on-task behavior as opposed to a large array of competing behaviors (Skinner et al., 2005).
Practical Implications

The results observed in the current study have several implications for practitioners in classrooms. First, results suggest that sensitivity to reinforcer dimensions varies across individuals. Therefore, an assessment of individual sensitivities to different reinforcement dimensions may be useful in informing the design of effective instructional programs (Neef et al., 1993). In addition, educators should be responsive to the need to adjust certain parameters of reinforcers associated with desirable behaviors. For example, it may be more efficient and effective for educators to alter task and response requirements of desirable academic behaviors if a student (e.g., Al and Mig) is more sensitive to changes in response effort. On the other hand, educators can also reinforce student selection of academic tasks with higher density of reinforcement for students (e.g., Mar) who are more sensitive to the schedule of reinforcement.

Second, the findings of the study suggest that sensitivity to reinforcer dimensions varies not only for individuals, but across situations. In applied classroom settings, dimensions of reinforcement (i.e., rate, immediacy, magnitude, and quality), along with response effort determine response allocation (Mace, 1994). Therefore, teachers may need to adjust dimensions of reinforcers in the context of available contingencies and student learning stage (e.g., fluency level). Thus, there may not be a single best alternative applied to every situation. For example, if assignment completion is based on the amount of time elapsed (e.g., independent seatwork), educators can make assignments more appealing by adding additional brief tasks on worksheets. However, the same procedure may be counter productive if it is applied to homework assignments because it increases the student response effort on the assignment. Therefore, when modifying
academic assignments educators need to match assignment variables (e.g., assignment length, complexity and student motivation) with the contingencies available in the environment to increase the probability of student selection of the material.

Third, the results of the study indicate that task-constant contingencies may be a promising academic assignment condition to increase student motivation to complete assignments. In addition, this type of contingency may be particularly beneficial when used as a class-wide intervention. For example, Hopkins, Schute and Garton (1971) investigated the effects of using a similar task-based contingency and access to playroom on student academic assignment completion. During an initial independent seatwork time, the teacher asked the students to remain at their seats to wait for the whole class to finish their assignments. The teacher then implemented a task-based contingency during intervention. Under the task-based contingency, each student was allowed to go to a playroom as soon as the student completed the assignment. They could stay in the playroom for the remainder of the independent seatwork time. Hopkins et al. found that the intervention resulted in significant increase in the rate and accuracy of task completion. When task-based contingencies are implemented to the whole class, it operates like independent group contingency and student performances are differentially reinforced. Hopkins et al. also reported that there was an increase in the quality of the student work. However, in the current study Al’s accuracy decreased dramatically during the task-constant condition (13% decrease on the traditional worksheets and 11% decrease on the interspersal worksheets). Similarly, Doyle, Jenson, Clark and Gates (1999) also found a decrease of the assignment quality for some students during a task-based contingency. Under the task-constant contingency, it was more efficient for the
students to work quickly than to work accurately to finish the work (i.e., obtain reinforcers). After Doyle et al. added an 80% accuracy criteria to the task-based contingency, all students improved their task accuracy by 29% without compromising rate of completion. Thus, educators can make task-based contingencies in combination with other criteria, such as class-wide behavior management procedures to improve student academic performance (e.g., Lannie & Martens, 2004).

Conclusions

The results of the study extended interspersal research in several ways. First, I investigated and compared the effects of the interspersal procedure on student choice of academic materials under task- and time-based contingencies. Second, I used a time-series single subject research design to study student response allocation when they had multiple opportunities to choose the material. Third, I extended the external validity of the interspersal procedure by including elementary age students with disabilities in the study. In addition, I used academic assignments and conditions that were similar to those used by the teacher in the applied classroom settings, thus further documenting the ecological validity of the procedure.

Overall, the results of the study showed that academic assignment and task conditions can interactively influence student selection of material and rate of academic task completion. The results have both theoretical and applied significance. On the theoretical level, this study tested the discrete task completion hypothesis and provided a direction for research on task interspersal within the framework of matching and variables affecting response allocating in applied settings. On a more applied level, it demonstrated that a combination of different types of assignment and task contingencies
could produce changes in density of reinforcement and response effort associated with
assignment completion. As a result, these changes may influence student selection of
academic materials and rate of responding to the material. The results of the study
suggest that sensitivities to reinforcement dimensions are highly individualized. When
designing effective instructional programs, educators need to not only analyze the
reinforcement contingencies that maintain the behavior, but also evaluate individual
sensitivities to the reinforcement dimensions.
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chronically disruptive students: An evaluation of outcomes in an alternative

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homework with 20% and 40% more problems: An investigation of the strength of

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performance and perception of math assignments: Getting students to prefer to do


behavior during mathematics independent seat-work in students with emotional disturbance by interspersing additional brief problems. *Psychology in the Schools, 39*, 647-659.


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giving them more word problems. *Psychology in the Schools, 36*, 319-325.


<table>
<thead>
<tr>
<th>Study</th>
<th>Participants</th>
<th>Target Tasks</th>
<th>Added Tasks</th>
<th>Ratio</th>
<th>Time</th>
<th>Choice</th>
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</thead>
<tbody>
<tr>
<td>Skinner, Robinson, Johns,</td>
<td>51 college students</td>
<td>16, 3 x 2 problems</td>
<td>1 x 1 problems</td>
<td>3:1</td>
<td>305</td>
<td>Inter</td>
</tr>
<tr>
<td>Logan, &amp; Belfiore, 1996</td>
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<tr>
<td>(Experiment 1)</td>
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<td>Logan &amp; Skinner, 1998</td>
<td>30, 6th grade students</td>
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<td>Wildmon, Skinner, McCurdy, &amp; Sims, 1999</td>
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<td>4 + 1 word</td>
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<td>Study</td>
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<td>Target Tasks</td>
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<td>Robinson &amp; Skinner, 2002</td>
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<td>18 mental computation</td>
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<td>2:1 –</td>
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<td>ND</td>
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<td>Billington, Skinner, Hutchins &amp; Malone, 2004</td>
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<td>1 x 1 problems</td>
<td>3:1</td>
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<td>Billington, Skinner, &amp;</td>
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<td>paragraphs</td>
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<td>McDonald &amp; Ardoin, 2007</td>
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*Note. Ratio = number of target tasks to added tasks; Time = required time in seconds; ND = No Difference; NA = Not Available.*
# APPENDIX - B. FEATURES OF THE STUDIES THAT INVESTIGATED THE MECHANISM OF THE PROCEDURES.

<table>
<thead>
<tr>
<th>Study</th>
<th>Participants</th>
<th>Target Tasks</th>
<th>Added Tasks</th>
<th>Ratio</th>
<th>Time</th>
<th>Choice</th>
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<td>Skinner, Fletcher, Wildmon, &amp; Belfiore, 1996</td>
<td>48 college students</td>
<td>16, 3 x 2 problems</td>
<td>2 / 1 problems &amp; 4 + 4 problems</td>
<td>3:1</td>
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<td>2 / 1</td>
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<td>Skinner, Robinson, Johns, Logan, &amp; Belfiore, 1996 (Experiment 2)</td>
<td>30 college students</td>
<td>16, 3x2 problems</td>
<td>3 / 2 problems &amp; 1 x 1 problems</td>
<td>3:1</td>
<td>305</td>
<td>1 + 1</td>
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<td>Skinner, Hall-Johnson, Skinner, Cates, Weber, &amp; Johns, 1999</td>
<td>94 college students</td>
<td>18, 4 x 1 problems</td>
<td>1 x 1 problems</td>
<td>3:1</td>
<td>255</td>
<td>Inter</td>
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<td>1 x 1 problems</td>
<td>3:1</td>
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<td></td>
<td>18, 4 x 3 problems</td>
<td>1 x 1 problems</td>
<td>3:1</td>
<td>255</td>
<td>Inter</td>
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<td></td>
<td>18, 4 x 4 problems</td>
<td>1 x 1 problems</td>
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<td>Cates &amp; Dalenberg, 2005</td>
<td>60 college students</td>
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<td>180</td>
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<td>15, 3 x 2 problems</td>
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<tr>
<td>15, 3 x 2 problems</td>
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<td>5:1</td>
<td>240</td>
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<td>ND</td>
</tr>
<tr>
<td>15, 3 x 2 problems</td>
<td>1 x 1 problems</td>
<td>3:1</td>
<td>240</td>
<td></td>
<td></td>
<td>Inter</td>
</tr>
<tr>
<td>15, 3 x 2 problems</td>
<td>1 x 1 problems</td>
<td>1:1</td>
<td>240</td>
<td></td>
<td></td>
<td>Inter</td>
</tr>
</tbody>
</table>

*Note.* Ratio = number of target tasks to added tasks; Time = required time in seconds; ND = No Difference.
## PROCEDURAL INTEGRITY CHECKLIST

<table>
<thead>
<tr>
<th>Step</th>
<th>Procedures</th>
<th>Yes (√)</th>
<th>No (X)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Greet the students “Hello / Hi ____ (student name)”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Follow the counterbalanced order of the worksheets and give student the</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>worksheets.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Read the task direction.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Start the stopwatch.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Stop the stopwatch.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Give student the other set of the worksheets and read the direction.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Start the stopwatch.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Stop the stopwatch.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Follow the counterbalanced location of the two worksheets (left and right)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>and present worksheets.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Read the choice question.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Give student the chosen worksheets.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Start the stopwatch.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>Stop the stopwatch.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>Thank the student.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
VITA

YOUJIA HUA

Education

<table>
<thead>
<tr>
<th>Degree</th>
<th>Year</th>
<th>Institution</th>
<th>Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>PhD</td>
<td>2008</td>
<td>The Pennsylvania State University</td>
<td>Special Education</td>
</tr>
<tr>
<td>MBA</td>
<td>2004</td>
<td>Gannon University</td>
<td>Business Administration</td>
</tr>
<tr>
<td>MS</td>
<td>2002</td>
<td>Mercyhurst College</td>
<td>Special Education</td>
</tr>
<tr>
<td>BA</td>
<td>1999</td>
<td>Shanghai University</td>
<td>English</td>
</tr>
</tbody>
</table>

Professional Awards/Recognition

- Graduate Student Recognition Award, The Pennsylvania State University, 2007
- Graduate Fellow, The Pennsylvania State University, 2004
- Graduate Award, Mercyhurst College, 2002
- Student Registration Grant, Society for the Advancement of Behavior Analysis, 2006, 2008

Professional Associations

- Association for Applied Behavior Analysis
- Council for Exceptional Children

Publications


