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MEASURING AND REDUCING COLLEGE STUDENTS' PROCRASTINATION

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We examined college students' procrastination when studying for weekly in-class quizzes. Two schedules of online practice quiz delivery were compared using a multiple baseline design. When online study material was made available noncontingently, students usually procrastinated. When access to additional study material was contingent on completing previous study material, studying was more evenly distributed. Overall, the mean gain in percentage correct scores on weekly in-class quizzes relative to pretests was greater during contingent access than during noncontingent access conditions.

Key words: college instruction, procrastination, self-control, study habits

College students prepare for quizzes and exams in many ways. Reading from the textbook, reviewing notes, and answering practice questions are among the methods they might employ. Some of these strategies improve test scores. Semb, Hopkins, and Hursh (1973), for example, gave college students in a child-development course practice questions in advance of a quiz. Subsequent quiz performance indicated that students were more likely to answer practice questions correctly than novel questions (i.e., questions they had not previously seen). In Bostow and O'Connor (1973), students who were allowed to take a remedial quiz when they performed below a set criterion (thus gaining extra practice with the material) received higher grades on a comprehensive final exam than students who were not given the additional practice. Ryan and Hemmes (2005) evaluated the effect of assigning homework on subsequent quiz performance and found that students received higher scores when they practiced related content between quizzes. Although these studies indicate that students perform better when given study material that is explicit and closely related to the material that will be tested, providing students with highly structured study materials may not be enough to facilitate high levels of performance on exams. Other factors such as when and how long students study may affect in-class exam performance.

When quizzes or exams are scheduled for a particular date, students might study a steady amount every day, or alternatively they might postpone their efforts until just before the scheduled quiz. The pattern of postponing study behavior has been described as procrastination (Born & Davis, 1974; Michael, 1991; Poppen, 1982). Although there are exceptions (e.g., Morris, Surber, & Bijou, 1978), college students perform more poorly when they procrastinate in preparing for a test rather than study at an even pace (Ariely & Wertenbroch, 2002; Lloyd & Knutzen, 1969; Mawhinney, Bostow, Laws, Blumenfeld, & Hopkins, 1971; Wesp, 1986). Mawhinney et al. (1971), for example, provided access to study materials only during arranged study periods and directly measured the studying of college students when exams were given at different intervals (daily or once every 3 weeks). As the intertest interval increased, students tended to distribute study-

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ing more heavily towards the end of the interval. Students also received lower test scores under the 3-week testing schedule.

The pattern of responding that typifies procrastination—gradually increasing from low levels at the start of the interval to a burst of responding at the end of the interval—has sometimes been referred to as scalloped (Born & Davis, 1974; Poppen, 1982). However, despite the superficial similarities to responding under a fixed-interval schedule, the controlling relations are thought to be different. Michael (1991) described one theoretical model for understanding the controlling relations that might produce this response pattern by college students preparing for an exam. By this account, students fail to study at the beginning of an interval before an exam because the upcoming test is so far in the future that it does not exert any control over studying. As the date of an exam approaches and students remain unprepared, however, the aversiveness of the impending exam increases. Studying then becomes increasingly likely and serves the function of reducing the aversive properties of the upcoming exam.

Research on self-control with aversive events suggests a way to operationalize procrastination (Deluty, 1978; Grusec, 1968; Lerman, Addison, & Kodak, 2006; Mazur, 1996). According to this model, self-control is demonstrated when, given a choice between an immediate aversive event and a delayed but relatively more aversive event, the immediate aversive event is preferred. In Lerman et al. (2006), children with autism chose between a small, immediate work task and a larger, delayed work task. For both children, choice was a function of the duration of the delay and the size of the tasks. The behavior of the children in the Lerman et al. study closely mirrors that of a student who procrastinates. In the case of studying for a test, students who choose to study small amounts across several days rather than waiting until the last moment to study are said to exhibit self-control. Procrastination, on the other hand, is demonstrated when students opt to delay studying, thereby exposing themselves to the delayed but more aversive state of being unprepared for the test.

Although procrastination is common among college students (Jarmolowicz, Hayashi, & Pipkin, 2010; Lamwers & Jazwinski, 1989; Lloyd & Knutzen, 1969), relatively few applied studies have attempted to reduce it. Previous attempts to address the issue have typically involved imposing intermediate deadlines for the completion of schoolwork to encourage a more evenly distributed pattern of studying (Lamwers & Jazwinski, 1989; Morris et al., 1978; Wesp, 1986). Lamwers and Jazwinski (1989), for example, compared different arrangements of deadlines within a class using a personalized system of instruction (PSI) and found that frequent deadlines reduced procrastination and improved grades compared to a fully self-paced arrangement. Ariely and Wertenbroch (2002) also decreased procrastination in a PSI course by requiring students who delayed their work past a certain date to meet with the professor and develop intermediate deadlines to keep them on pace. The students who received additional deadlines had better outcomes in terms of grades and dropout rates than the students who had fewer deadlines. In addition, other research findings indicate that both the delivery of points for meeting deadlines and loss of points when deadlines were missed may positively affect quiz scores (e.g., Reiser, 1984). Although these findings are promising, further investigation into the attenuation of procrastination is warranted. For instance, in these studies, the student behaviors of concern were primarily the completion of independent assignments rather than studying for an exam. Interventions that alter the distribution of assignment completion may have little effect on studying outside those assignments. Also, the experimenters (Ariely & Wertenbroch, 2002; Lamwers & Jazwinski,

1989; Morris et al., 1978; Reiser, 1984; Wesp, 1986) employed between-groups experimental designs to evaluate the effects of their intervention, thus limiting conclusions as to the effects of the interventions on individual patterns of behavior.

Although deadlines may sometimes reduce procrastination, they do not directly address the hypothesized function of procrastination. Typically, a deadline imposed by a teacher involves the threat of an aversive consequence (e.g., failing the assignment) if the desired academic behavior is not performed by the specified date. Thus, improved studying due to an intervention of this kind would appear to be maintained by negative reinforcement in the form of avoiding some additional teacher-delivered aversive consequence. It might be valuable to find other ways to influence student behavior that do not rely on the threat of failing. One such alternative would be to program contingencies by which engaging in distributed studying would result in positive reinforcement. Although a large body of research has demonstrated that positive reinforcement can improve academic behavior, we found no studies that examined the use of positive reinforcement to change patterns of studying.

The current study examined three questions related to the topic of procrastination. First, we examined the extent to which college students procrastinated in answering optional practice questions while preparing for weekly quizzes. Next, we investigated the effects of programming a contingency that required students to answer some of the questions earlier in the week to gain access to additional study questions. Finally, we evaluated whether distributed studying would lead to better quiz scores than procrastination.

METHOD

Participants and Setting

Participants were 11 graduate students (seven doctoral and four masters; two male and nine female) enrolled in a 10-week single-subject design course at a large midwestern university. Although small, the group represented three different academic programs. Students were informed that an instructional methodology was being evaluated in their class, but they were not informed as to the details of the independent and dependent variables. All students in the course gave consent for their data to be included in this study.

The in-class component of this study (i.e., in-class quizzes) was conducted in a university computer lab. The room was furnished with chairs, tables, and desktop computers connected to the Internet. The students used the university computers to take the pretest and in-class quizzes. At least one of the authors was present during the in-class component.

Materials

Three types of computer-based assessments were used to measure performance: (a) a pretest, (b) weekly in-class quizzes, and (c) practice quizzes. Each assessment was accessed through the course Web site and consisted of multiple-select questions, a variation of multiple choice in which multiple answer options could be correct. All assessments were scored automatically by the university's Web-based program. Participants received full credit only if all of the correct answer options were selected and incorrect answer options were not selected. Otherwise, participants received partial credit when some but not all of the correct answer options were selected or no credit when none of the correct answer options were selected.

Three equivalent sets of 10 questions were developed for each week. Equivalent questions were questions that assessed the same content area yet were worded differently or provided different answer options. One version of each question was used during the pretest and in-class quiz, and two versions were used for the practice quizzes.

Pretest. During the first class session, the students (with the exception of P6, who was

absent) took the pretest. The pretest contained questions across all eight instructional units, totaling 80 questions. Thus, the pretest encompassed all of the content that would be taught throughout the course. Students were informed that the pretest would have no bearing on their grades but would be important in determining their progress over the course, so it was asked that they take it seriously and try their best. Scores on the pretest were not reported to the participants.

In-class quizzes. Eight weekly in-class quizzes, which functioned as the posttest, were taken in the computer laboratory during the first 30 min of the class. All in-class quizzes contained 10 questions from the pretest that reflected the content areas to be covered during the lecture portion of that day's class. In addition, participants were given immediate feedback after completion of the quiz, and the quiz score was factored into their course grade. In-class quiz scores accounted for 10% of the course grade.

Practice quizzes. Students could access up to five practice quizzes each week. The first practice quiz contained four questions covering two content areas. The second practice quiz contained eight questions (four from the first practice quiz plus four new questions) covering four content areas. This pattern continued until the fifth and final practice quiz, which contained 20 questions covering 10 content areas. It is important to note that only the fifth practice quiz included all of the content that would be assessed on the in-class quiz. The question order was randomized across each practice quiz. To decrease the likelihood that students would print the practice quizzes for offline studying, only two questions were displayed on the computer screen at one time.

Like the pretest, the practice quizzes had no bearing on the student's grade, were multiple-select questions, were accessed through the course Web site, and were scored automatically. However, unlike the pretest, students received immediate feedback after completion regarding their scores as well as the correct answer options for each question. Access to the practice quizzes was determined by the experimental conditions described below. The practice quiz was available until 30 min before class after access was granted to a student. These quizzes could be taken an unlimited number of times and could be accessed from any computer with Internet capabilities (e.g., a home computer) at any time. The questions on the practice quiz remained the same regardless of the number of times the student accessed it.

Dependent Measures

All data were collected by the university's computer system server. Frequency data were collected for practice quizzes completed. A quiz was scored as completed if the participant clicked the ''submit quiz'' option on the computer screen. The date and time were recorded when each quiz was completed. All quiz questions were scored as correct or incorrect by the university's computer system by dividing the number of correct responses by the number of possible correct responses. These data were reported as percentage correct for each quiz.

Procedure

Two schedules of online practice quiz delivery—noncontingent and contingent access—were compared using a multiple baseline design across participants. During the first class, students were informed that practice quizzes would be available on the course Web site to aid in their studying for in-class quizzes; baseline contingencies were also explained. Rules explaining treatment contingencies were e-mailed to each student when the condition changed, as well as after breaks in the course schedule due to holidays (the start of Weeks 7 and 8).

Noncontingent access (baseline). Access to practice quizzes was based on a noncontingent fixed-time (FT) 24-hr schedule. Starting the morning after the class session, one practice quiz was made available per day at 6:30 a.m.

until all five practice quizzes were accessible. For example, if class was on a Wednesday evening, the first practice quiz could be opened Thursday morning. Quizzes 2, 3, and 4 could be opened on Friday, Saturday, and Sunday mornings, respectively, and the final practice quiz was available on Monday morning.

Contingent access. Access to the first practice quiz was provided noncontingently the morning after class. However, access to the subsequent practice quizzes was contingent on completion of the prior practice quiz. For example, the participant must have completed the first practice quiz to gain access to the second practice quiz. Access to the next earned practice quiz was granted the following morning at 6:30 a.m. Thus, the participant could gain access to only one additional practice quiz per day. As a result, participants who did not complete the first practice quiz by the third day following class would not have enough time to access all five practice quizzes.

Acceptability Ratings

Participants completed a social validity questionnaire anonymously on the last day of class. They were asked to circle a value on a 5-point Likert-type scale (or "not applicable") indicating the extent to which (a) practice quizzes were helpful in preparing for in-class quizzes, (b) they preferred practice quizzes to other means of studying, (c) they believed practice quizzes added to their preparedness for in-class quizzes, (d) they liked each schedule of practice quiz access, (e) they would like practice quizzes in future classes, (f) they printed practice quizzes for offline use, and (g) they used practice quizzes and other means of studying. In addition, participants were asked open-ended questions regarding which course components they would suggest continuing and discontinuing.

RESULTS

The cumulative numbers of practice quizzes completed by each individual during baseline and treatment are shown in Figures 1 and 2. During baseline when access to practice quizzes was noncontingent, 10 of 11 participants (all except P4) completed few practice quizzes early in the week. Although P3 (Figure 1, bottom) exhibited more consistent responding during the initial weeks of the course, this pattern soon degraded. When access to additional practice quizzes was contingent on completing earlier practice quizzes, six participants (Figure 1) demonstrated a more evenly distributed pattern of responding. Although P7 and P10 (Figure 2) also started completing quizzes earlier in the week during contingent access than during baseline, the effect on response patterns was not as clear.

There were some notable exceptions to the general response pattern observed during the study. During noncontingent access, P4 (Figure 2, bottom) often accessed the practice quizzes on 5 of the 7 days. As a result, he remained in the baseline condition throughout the study. Practice quizzes were rarely accessed by P8 (Figure 2, third panel). On the few occasions when she did complete a practice quiz, it occurred during the last 3 days of the week, irrespective of the condition. During contingent access, P10 (Figure 2, second panel) initially accessed the online quizzes throughout the week; however, overall responding decreased and more closely resembled baseline patterns toward the end of the phase.

Figure 3 (top) depicts the percentage of days on which each participant completed at least one practice quiz during the noncontingent and contingent access conditions. All participants completed practice quizzes across more days in the contingent access condition than in the noncontingent access condition, except P4, who did not experience the contingent access condition. The mean percentages of days on which practice quizzes were completed were 31% (range, 10% to 61%) during the noncontingent access condition and 56% (range, 14% to 79%) during the contingent access condition.

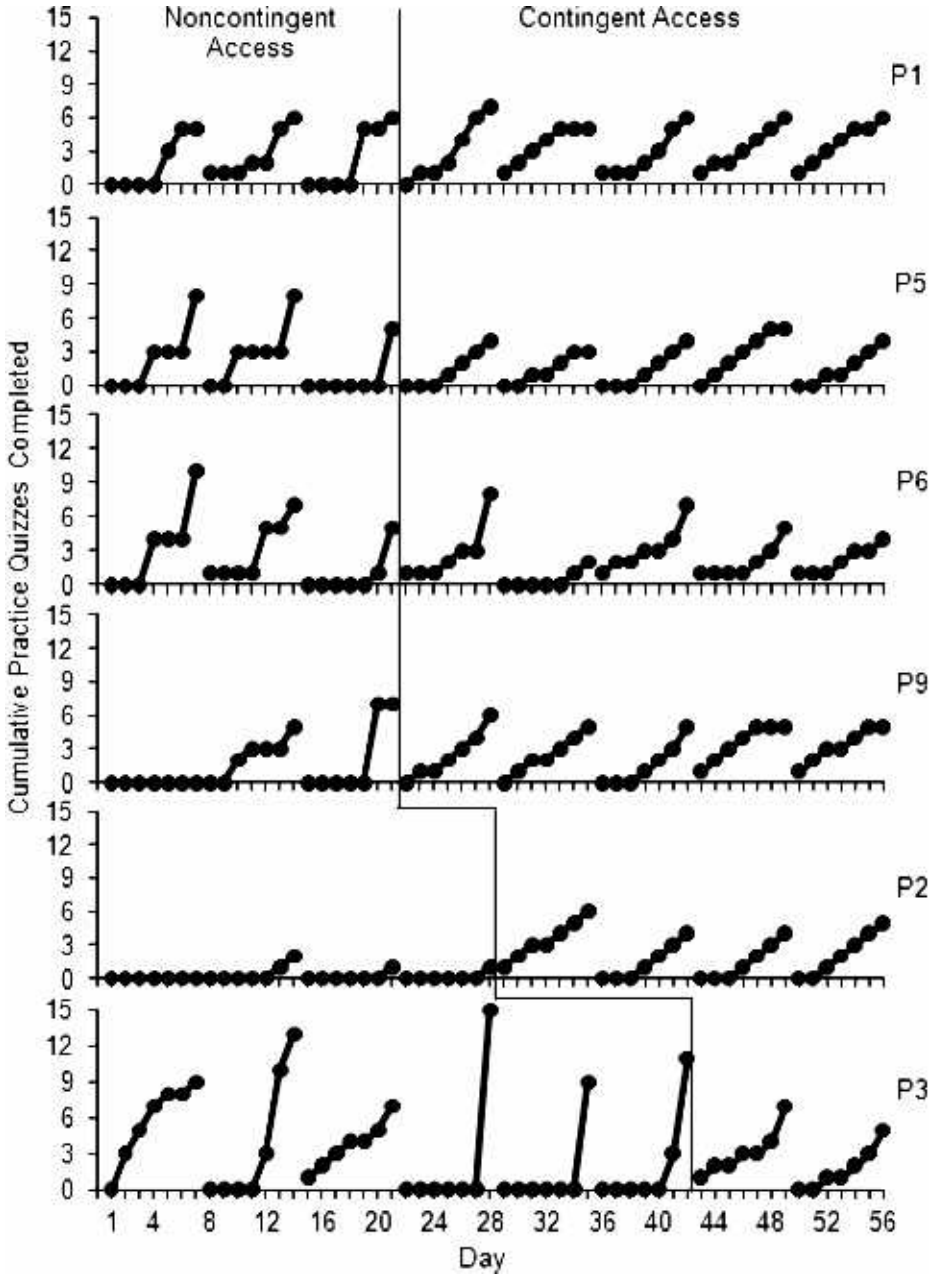

Figure 1. Cumulative number of practice quizzes completed each day (separated by week) across noncontingent and contingent access conditions for Participants 1, 5, 6, 9, 2, and 3. Breaks due to holidays occurred following Days 42 and 49.

Figure 3 (bottom) depicts differences in performance across the two conditions as mean percentage gain from the pretest (note that because P6 did not take the pretest and P4 had no contingent access data, they were not included in this analysis). To calculate mean gains, we subtracted the pretest quiz score from the posttest quiz score and averaged the

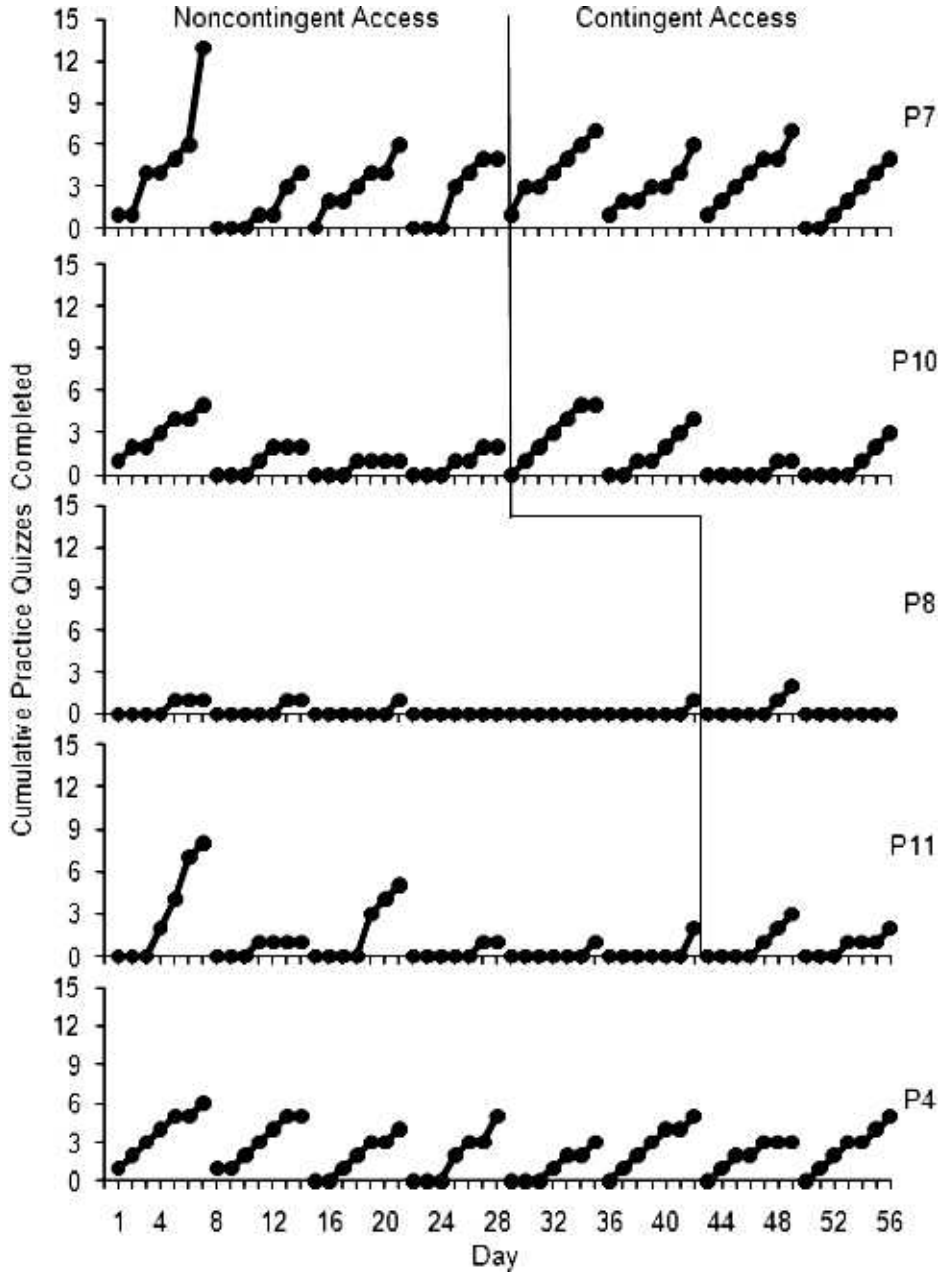

Figure 2. Cumulative number of practice quizzes completed each day (separated by week) across noncontingent and contingent access conditions for Participants 7, 10, 8, 11, and 4. Breaks due to holidays occurred following Days 42 and 49.

differences. Seven of the 9 participants with pretest and posttest scores for both conditions demonstrated an increase in gains during the contingent access condition relative to baseline. During the noncontingent access condition, the mean gain across participants was 16% (range, 5% to 34%), whereas the mean gain was 21% (range, 7% to 31%) during the contingent

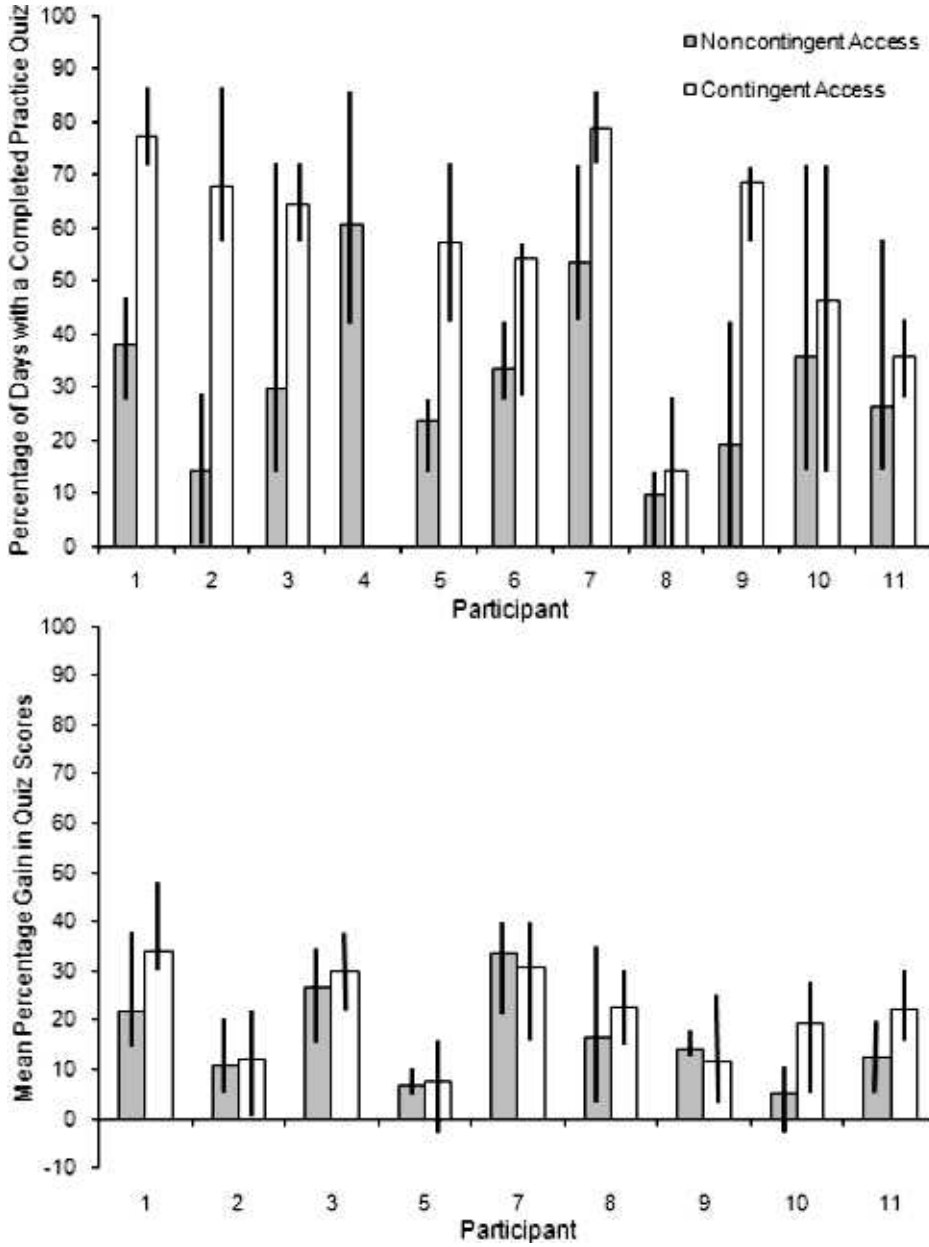

Figure 3. Percentage of days with a completed practice quiz across noncontingent and contingent access conditions (top). Mean percentage of gain score across noncontingent and contingent access conditions (bottom). Error bars represent the range of percentage of days with a completed practice quiz (top) and range of mean percentage gain in quiz scores (bottom).

access condition. This was a statistically significant difference when gain scores were compared using a paired sample t test, $t(18) = -2.21$, $p = .02$.

Ten of 11 participants provided responses to the social validity questionnaire. All respondents indicated that they found the practice quizzes to be useful in preparing for in-class

quizzes, with 40% preferring the practice quizzes to other means of studying. Furthermore, 80% of the respondents reported feeling more prepared for the in-class quiz as a result of using the practice quizzes. Although 20% of respondents indicated that they liked earning access to practice quizzes because it helped to pace their studying, when given a choice between the two conditions, 90% of respondents preferred noncontingent access to the practice quizzes.

DISCUSSION

Results showed that in the absence of treatment, most participants studied very little in the first part of the week, and then engaged in a burst of studying towards the end of the week. During treatment, participants shifted their studying to a more evenly distributed pattern of completing the practice quizzes. This temporally distributed pattern of responding represents a decrease in procrastination. Furthermore, this change in responding proved to be quite durable. Due to holidays, class did not meet for 2 of the final 4 weeks of the academic term. As a result, participants had an entire week free of quizzes and studying. The data, however, show that after students returned to the school environment and received the rules via e-mail, their response patterns returned to preholiday norms. In addition, most participants performed better on the in-class quizzes during the treatment condition than in baseline. The improvement in scores during treatment varied among participants, but in general, it was equivalent to half a letter grade.

The pattern of responding observed in this study fits both Michael's (1991) model of procrastination and the self-control with aversive events model (e.g., Deluty, 1978; Grusec, 1968; Lerman et al., 2006). The unevenly distributed pattern of studying during baseline was likely produced by forgoing regular occurrences of small amounts of studying for larger delayed study sessions. It is plausible that as time passed, being unprepared for an exam became increasingly aversive. This served as a motivating operation for studying, thereby increasing the likelihood of studying toward the end of the week. For example, when participants did not regularly access practice quizzes (e.g., complete one practice quiz per day), they often completed large numbers of practice quizzes on the final day of the week (see baseline responding for P3, P5, P6, P7, and P9 in Figures 1 and 2). However, contingent access to additional practice quizzes produced studying earlier in the week, increasing preparedness and potentially attenuating motivation to engage in large bursts of studying at the end of the week. Except for a few occasions (see Days 28 and 42 for P6 in Figure 1), large amounts of delayed studying did not occur when regular responding occurred throughout the week.

In addition to a more stable rate of studying, exposure to treatment led to an overall improvement in quiz scores compared to pretest scores. Michael (1991) noted that studying as a means of decreasing the aversiveness of being unprepared is effective only insofar as it results in good grades. If studying does not affect exam grades or affects grades negatively, it is not likely to be exhibited in the future. That the intervention led to increased quiz scores over baseline scores for 7 of 9 participants indicates that contact with the intervention may be effective in improving preparedness for in-class quizzes, thus serving the function of negative reinforcement. Given this outcome, participants may continue to exhibit steady responding in the absence of contingent access to practice quizzes when this contingency is removed (i.e., during a return to baseline). However, results of the social validity questionnaire indicated that participants overwhelmingly preferred noncontingent access to contingent access, suggesting that treatment effects might not be maintained. Unfortunately, time constraints did not allow us to assess maintenance.

The current intervention closely mirrors Malott's (2005) application of the performance-management model of task accomplishment to higher education. Key components of this model include dividing large tasks into smaller tasks, explicitly defining smaller tasks with frequent deadlines, and reinforcing completion of the small tasks. In the present intervention, the total amount of material covered on an in-class quiz was divided into five smaller quizzes, thus decreasing the size of the task as well as clearly defining material that should be studied. In addition, deadlines that required almost daily practice-quiz completion were incorporated into the reinforcement contingency for studying.

One way to characterize the programmed schedule of reinforcement in the contingent access condition is as a conjunctive fixed-ratio (FR) 1 FT 24-hr schedule. Under this schedule, the opening of an additional quiz was contingent on fulfilling two requirements: At least one study response had to have occurred, and a 24-hr period from the opening of the previous practice quiz had to elapse. In the conjunctive FR FT schedule, the FR schedule should act to increase the frequency of the studying response, and the FT schedule ensures that responding is temporally spaced. Similar results have been found in studies with nonhuman animals; when rats' lever presses were reinforced on conjunctive FR FT schedules, responses tend to occur towards the middle of the FT period (Keenan & Leslie, 1986; Zeiler, 1976). This may be a reasonable approach to achieving the desired temporal pattern of responding needed to reduce procrastination.

Another interpretation of the contingencies in this study is that we differentially reinforced a temporal distribution of responding. In this regard, the intervention may resemble schedules used to reinforce response variability. A number of studies have demonstrated that differential reinforcement can increase variability among members of a response class (see Neuringer, 2004). In studies with nonhuman animals, operant procedures have been used to increase variability along response dimensions such as response sequence (Page & Neuringer, 1985), topography (Pryor, Haag, & O'Reilly, 1969), and interresponse time (Blough, 1966). In the current study, responses were required to vary by temporal locus (i.e., occurring on multiple days of the week) to maximize reinforcement. If a student responded on fewer days of the week, not all quizzes were available. Contingencies that have been used to reinforce variation, such as lag schedules (e.g., Lee, McComas, & Jawor, 2002; Page & Neuringer, 1985) or schedules that differentially reinforce low-frequency members of a response class (e.g., Miller & Neuringer, 2000), might also be effective in reducing procrastination.

Although the intervention was effective in altering studying patterns and improving quiz scores, the study has several limitations. First, the number of times that a participant contacted each individual question may have differed across conditions. Because practice quizzes were cumulative, access to an entire set of questions during contingent access required that participants complete the questions from the first practice quiz four times, the second practice quiz three times, the third practice quiz twice, and the fourth practice quiz once. However, in baseline, participants could wait until the fifth practice quiz was available, thus accessing the entire set of questions with no previous exposure. Thus, additional practice, as opposed to evenly distributed studying, might have been responsible for the improved grades. Even if this was the case, it speaks to the relative merit of contingent access to the practice quizzes versus noncontingent access for increasing students' contact with the relevant study materials.

A second limitation is that the only measure we had of the participants' studying was the data produced by the course Web site. Thus, it is possible that participants could have shared

access to practice quizzes or printed the quizzes for offline use (four of the 10 participants indicated on the social validity questionnaire that they had printed the practice quizzes to use as study aids). Furthermore, participants could have formed study groups, used flash cards, or created other study materials used outside the class to complement the practice quizzes. It is likely, however, that such extraneous variables would have occurred consistently across conditions. These limitations could have been avoided had we opted to tightly control access to the study material (e.g., Mawhinney et al., 1971) or based the quizzes on materials that the participants could not freely access. This seemed counter to the purpose of the study, however, in that one advantage of this intervention is that participants could freely access the materials via the course webpage and thus study whenever they wanted to.

A third limitation concerns the practicality and social validity of an intervention that requires daily monitoring by an instructor. Although the course Web site delivered the practice quizzes, the experimenters were responsible for monitoring and assigning access to the practice quizzes. In addition, the participants indicated a strong preference for noncontingent access over contingent access. However, this preference may be due in part to a contrast effect established by the transition from one schedule to the next. Outside the context of a study, contingent access to practice quizzes would be in effect for the duration of a course, eliminating these effects. Also, variations in the schedule of quiz delivery (e.g., a conjunctive FR 2 FT 48 hr, which would necessitate studying on fewer days to access all of the practice quizzes) may prove to be equally effective at attenuating procrastination and have greater social validity. Finally, advances in course management systems should enable a contingency such as the one used in this study to be implemented automatically, thereby minimizing the effort required to monitor and assign quiz access.

Overall, this intervention effectively altered the pace at which participants studied. Future research in this area should focus on replications with different groups of participants. For example, although this intervention was effective for graduate students, undergraduates might be a population more in need of effective ways to study. A study that attempts to replicate these results should assess whether distributed studying continues after treatment is removed. Also, the extent to which studying must be distributed to improve students' quiz grades remains unknown. The ultimate utility of this intervention would come from a model that is easily implemented and produces meaningful and lasting improvements in both studying and mastery of material.

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