

Strategies to Reduce Procrastination in College Students

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Abstract: Students usually procrastinate, which might increase anxiety levels and decrease test scores. Previous studies used between-groups comparisons to explore ways to deter procrastination, a design that did not allow analyses of individual procrastination patterns. In the present two studies, college students' individual self-regulation and procrastination patterns were investigated in a within-subject design to identify strategies that promote self-regulation and decrease procrastination. Each week, participants alternated between two schedules of delivery of practice quizzes while preparing for weekly quizzes. In Study 1, one practice quiz was available per day in a noncontingent condition. In a contingent condition, participants had to submit one practice quiz per day to access a subsequent practice quiz. In Study 2, two practice quizzes were available every other day in a noncontingent condition. In a contingent condition, participants had to submit two practice quizzes every other day to access subsequent practice quizzes. Across the two studies, 6 of 25 participants stopped procrastinating at the end of the contingent condition, and both conditions yielded high scores on weekly quizzes even when participants procrastinated. These results indicate that college students' procrastination patterns can be changed, although it does not necessarily lead to increased quiz scores. The present studies propose a methodology to investigate and change self-regulation and procrastination patterns at the level of the individual.

Keywords: procrastination, quizzes, self-regulation, study habits, college students.

Self-regulation has been defined as the extent to which a person can change their behavior (Muraven et al., 1999). This concept is especially useful when the person struggles with a problem and/or lacks external alternatives to deal with it, such as access to educational resources or counseling sessions.

Among the several problem behaviors that an individual might display, procrastination probably affects us all. Procrastination is the act of postponing a task. In college, procrastination might lead to anxiety (K. Johnson & Ruskin, 1977; Wesp, 1986) and an increase in the aversiveness of the task (Michael, 1991), which rises as the deadline approaches with much work still to be done.

In terms of academic behaviors, procrastination yields bursts of studying periods before task deadlines and exams (e.g., Jarmolowicz et al., 2010; Mawhinney et al., 1971; Perrin et al., 2011). As procrastination progresses along with increased levels of aversiveness of the task, the student escapes from this aversive situation by procrastinating even more until the point that the escape from the task is no longer possible since the threat of receiving a failing grade for not completing the task is imminent. Then, when faced with the options of an aversive failing grade or an aversive task to complete, the student might escape from the former by choosing the latter (P.E. Johnson et al., 2016; Perrin et al., 2011).

Researchers have documented an increase in the frequency of response behaviors as a deadline approaches, referred to by some authors as a scalloped pattern of responding (e.g., Michael, 1991). Mawhinney et al. (1971) noticed this pattern when they compared how undergraduate students allocated their study opportunities under daily and weekly test schedules. Study materials were made available to participants in a study room where an observer recorded the distribution and duration of students' handling of the materials. The test schedules alternated between weeks for all participants at the same time. The participants exhibited different study patterns during the daily and weekly tests.

Under the daily test treatment, average study time ranged from 31 to 140 min, but participants attended the study sessions daily. During the weekly tests, in contrast, students spent more time with the study materials as the dates of the tests approached, indicating a scalloped pattern of study.

Students who work at a regular pace and finish tasks on time, that is, students who do not procrastinate, acquire more learning skills (Keller, 1968; Michael, 1991) and improve the quality of their work (e.g., Harris, & Sherman, 1974; P.E. Johnson et al., 2016; Olympia et al., 1994; Perrin et al., 2011). The insufficient time left to complete a task when students procrastinate might be responsible for the documented low performances (e.g., Ariely & Wertenbroch, 2002; Lloyd & Knutzen, 1969; Mawhinney et al., 1971; Wesp, 1989). For example, Lloyd and Knutzen (1969) gave students a list of expectations to be met during a course, including class attendance and participation, movie and book reviews, extra readings, research participation, a lab experiment, field trips, and a class project, and the corresponding number of points to be earned. Final grades depended on the number of points accrued at the end of the semester. The results show that the students' grades were correlated with the time the students started completing their work. Students who earned As started working within 2 weeks of the beginning of the course and those who earned Bs, within 4 weeks, while students who earned Cs and Ds began working toward the end of the course. Moreover, the final grades were associated with how students distributed their work. Students who finished the course with As and Bs tended to earn between 50 and 200 points every 2 weeks throughout the course, showing a relatively distributed pattern of work completion. But students who earned Cs and Ds accumulated around 20 points every 2 weeks during the first 12 weeks but earned between 300 and 400 points in the last 2 weeks of the course. Thus, having several deadlines can help students earn higher grades and work regularly throughout a course.

Some of the studies that attempted to reduce procrastination applied a between-groups design (e.g., Ariely & Wertenbroch, 2002; Reiser, 1984; Wesp, 1989) and reported the results in aggregated forms, such as means scores, and did not account for analyses of participants' procrastination patterns. For instance, Ariely and Wertenbroch (2002) investigated the extent to which self-imposed deadlines helped college students avoid procrastination. The control group was given three evenly spaced deadlines while participants in the choice group could select the date on which they would commit to submitting each essay. Students had to announce the self-imposed deadlines at the beginning of the course and could not alter them later. Moreover, 1% of the grade was deducted for each day a submission was late. On average, participants in the choice group submitted the first essay 42 days before the final day of classes, the second essay 26 days before the end of the semester, and the third essay 10 days before the end of the semester. Only 27% of the participants chose to submit all three essays on the last day of classes. The no-choice group exhibited higher grades—mean grade of 89—compared to the students in the choice group, who scored on average 86. These results indicate that the students were willing to self-impose costly deadlines even when they could choose deadlines with less commitment and less penalty such as the last day of classes. Although the results are interesting, the reported means do not allow for an evaluation and understanding of each student's procrastination pattern or even whether students altered their study patterns during the study.

Between-groups designs not only lack a provision for analyzing individual students' study patterns but also subject some participants to a condition that might not foster learning and/or might lead to lower test scores or final grades, which poses an ethical problem (Haggas & Hantula, 2002). Thus, within-subject designs can be a better method to investigate, understand, and deter procrastination.

Among the strategies to reduce procrastination are consequences provided each time the student turns in late work (Ariely & Wertenbroch, 2002; P.E. Johnson et al., 2016). P.E. Johnson et al. (2016) used a within-subject design and developed a rule to account for on-task submission and task quality of college students. When participants were exposed to the treatment condition, they were

warned that if they did not submit a precursor assignment, the due date for the final essay would be advanced by 2 days, a rule that was not applied when the participants were in the control condition. The rule reduced procrastination for some students; nevertheless, it involved an aversive component (moving the deadline 2 days closer), like the 1% grade deduction imposed by Ariely and Wertenbroch (2002). Aversive components in school contexts might produce negative consequences, such as anxiety and school dropout (Sidman, 1989). In this sense, teaching methods that also involve positive consequences might be more beneficial to students (P.E. Johnson et al., 2016; Sidman, 1989).

Perrin et al. (2011) developed a within-subject design to attempt to use positive consequences, such as access to practice quizzes after submission of homework, to reduce procrastination in graduate students. Each week, one of two online practice quiz schedules (contingent or noncontingent schedule) was available before an in-class quiz. In both schedules, participants could take up to five practice quizzes. In the contingent schedule, the first quiz was made available noncontingently. For each of the following four practice quizzes, the participant had to submit a practice quiz to have access to another practice quiz on the following day. In the noncontingent condition, one practice quiz became available per day regardless of whether the participant had submitted a previous practice quiz. Thus, access to another practice quiz increased the completion of a previous quiz and led to higher scores with graduate students. However, it has yet to be investigated whether the same procedure would have similar results with undergraduates, which might be a population more in need of interventions to develop self-regulation strategies, as measured by studying and time-management skills.

Study 1

The twofold objective of Study 1 was (a) to examine college students' self-regulation and procrastination patterns when preparing for weekly quizzes and (b) to assess if an instructional methodology of providing optional practice quizzes would reduce procrastination and increase students' grades on the quizzes.

Method

Participants

Undergraduate students enrolled in an introductory behavior analysis course were invited to participate in the study by allowing the researcher to collect data about their performance in the course. Participants were informed that an instructional component of the course was to be evaluated. However, they were not informed about the dependent and independent variables. Participants signed an informed consent form and received research credit hours in exchange for their participation. Thirty participants gave consent to participate in the study but 24 were excluded because they failed to submit one or more weekly quizzes or did so after the deadline, which might have affected their studying patterns, a focus of this study.

Setting

A pretest was administered in class using paper and pencil to prevent participants from copying, saving, or sharing the pretest questions, since the pretest and weekly questions (posttest) were identical. Participants were not informed of the similarity of the questions.

Participants accessed the practice and weekly quizzes using Blackboard, an online instructional

management platform. Questions in Blackboard were scored automatically by the platform as correct or incorrect and the scores, as well as the questions and student' answers, appeared on the screen after the quiz was submitted. If an answer was incorrect, Blackboard indicated the correct answer.

Materials

Fifty multiple-choice questions covering the topics that were discussed in the course were developed. Questions were divided into three types of quizzes: the pretest, optional practice quizzes, and weekly quizzes. The pretest and weekly quiz questions were identical. Optional practice quiz questions covered the same topics as the pretest and weekly quiz questions, but they were reworded or had different answer alternatives.

Procedure

Pretest. The objective of the pretest was to assess participants' performance on all 50 multiple-choice questions that were used in the study. Later, participants' scores on the pretest questions were compared against their scores on the weekly quizzes.

The pretest was administered on the second day of class. Participants were informed that their performance on the pretest would not count toward their grade. Nevertheless, they were asked to try their best, as the questions would be used to assess their achievement in the course. Participants turned in the pretest to their instructor and neither received it back nor were informed about their scores and correct answers.

Optional practice quizzes. The objective of the optional practice quizzes was to analyze participants' procrastination patterns in each condition while preparing for weekly quizzes. Participants were able to take a maximum of five practice quizzes every week. The first practice quiz contained two questions about one of the five topics to be covered on the weekly quiz. The second practice quiz contained the same questions from the first practice quiz and an additional two questions. This structure continued until the fifth optional practice quiz, which contained 10 questions dealing with all five topics to be covered on the weekly quiz. Questions were randomized by the platform for each practice quiz.

Participants were informed that their performance on the practice quizzes would not count toward their grade. However, they were informed about their score on each practice quiz and correct answers. Once a practice quiz was made available to a participant, they were able to access it an unlimited number of times.

Optional practice quizzes were delivered using a within-subject design with a contingent (treatment) and a noncontingent (control) condition. All participants alternated between conditions each week and at the same time, starting with the noncontingent condition, and experienced each condition five times. Participants received an email containing information regarding the availability of optional practice quizzes in that week.

Contingent condition. The first optional practice quiz became available on a Thursday at 12 noon. The remaining optional practice quizzes became available contingent on the participant's submission of previous practice quizzes. If a participant submitted one practice quiz they had access to another optional practice quiz on the following day at 12 noon. Thus, if a participant started submitting the first practice quizzes earlier in the week, they would be able to finish all five optional practice quizzes before the weekly quiz on Wednesday, for example, taking the first quiz on Thursday, the second on Friday, the third on Saturday, the fourth on Sunday, and the fifth on Monday.

Noncontingent condition. In this condition, one practice quiz became available per day at 12 noon, starting on a Thursday, until all five optional practice quizzes had been released. Therefore, the five

optional practice quizzes became available regardless of participants' submission of previous practice quizzes in the noncontingent condition.

Weekly quiz. The weekly quiz served as a posttest measure to see whether participants' scores would increase after taking the optional practice quizzes across conditions. There were 10 weekly quizzes in total, one per week. Participants were automatically informed about their score and correct answers. Weekly quizzes made up 35% of a student's final grade.

Social validity questionnaire. At the end of the study, participants completed a social validity questionnaire (see Appendix) anonymously, which assessed their opinions regarding the teaching method.

Results and Discussion

Figure 1 presents the percentage of correct answers on the pretest and mean percentage of correct answers on weekly quizzes (columns), as well as the number of practice quizzes submitted in the contingent and noncontingent conditions (data points) across participants. All six participants increased their scores from pretest (range, 30% to 61%) to weekly quizzes, which served as posttests (range, 88% to 100%). Participants exhibited similar percentages of correct answers in both conditions (range, 88% to 96% in the noncontingent condition and 80% to 100% in the contingent condition). These results indicate that both schedules of practice quizzes can yield high scores on weekly quizzes.

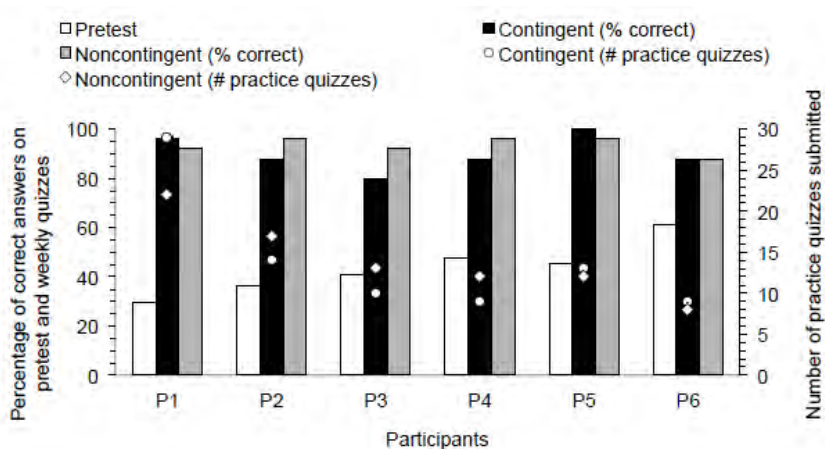


Figure 1. Percentage of correct answers on the pretest and mean percentage of correct answers on the weekly quizzes (columns), and number of practice quizzes submitted (data points) in the contingent and noncontingent conditions across participants (P1 through P6) in Study 1.

There was also no difference between conditions in terms of the number of optional practice quizzes submitted. One participant (P1) submitted more practice quizzes in the contingent condition, three participants (P2, P3, and P4) submitted more practice quizzes in the noncontingent condition, and the remaining two participants (P5 and P6) submitted a similar number of practice quizzes in both conditions. This result also suggests that the high scores on weekly quizzes might not be related to the number of practice quizzes submitted. Figure 2 presents the cumulative number of practice quizzes submitted per day in the noncontingent and contingent conditions.

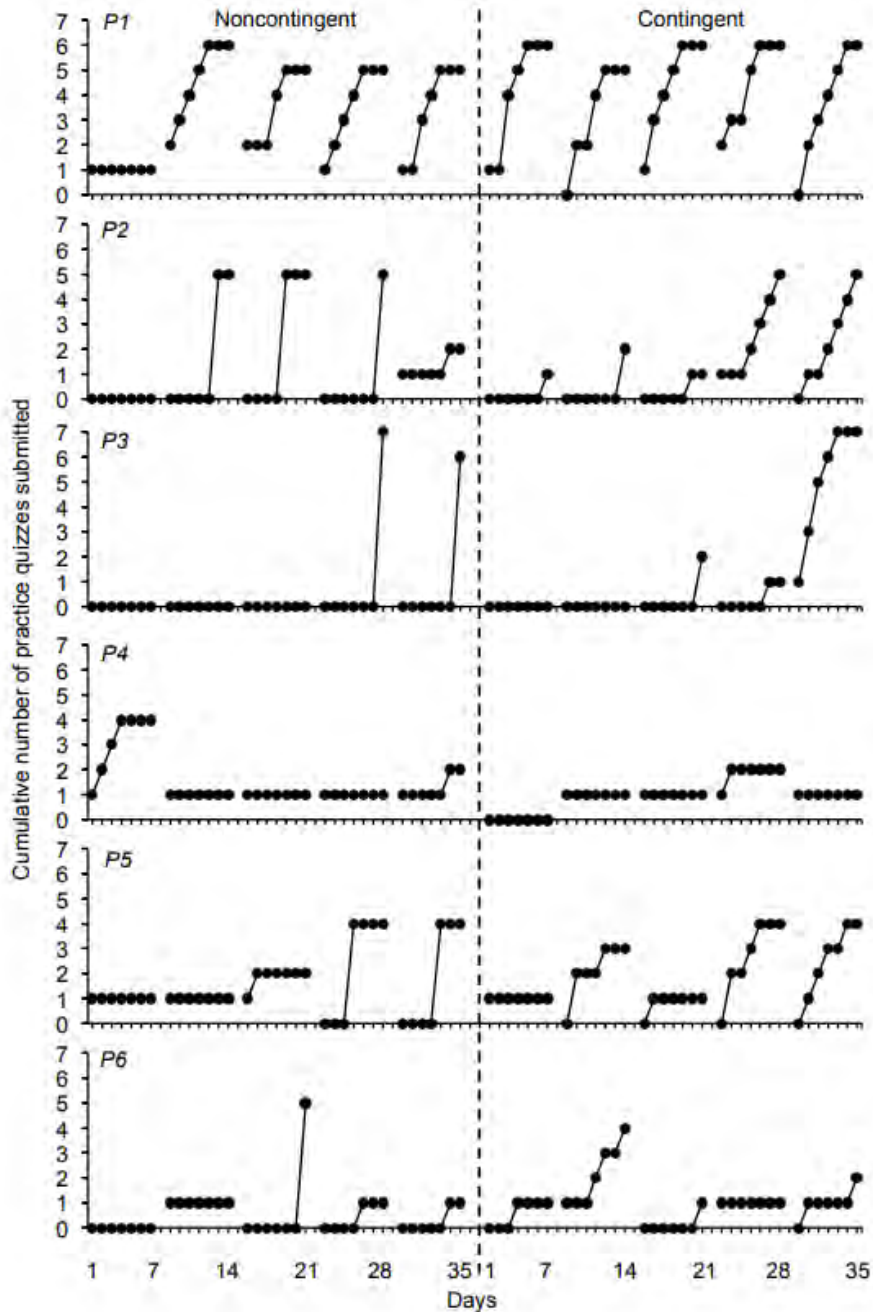


Figure 2. Cumulative number of practice quizzes submitted per day in the noncontingent and contingent conditions for participants (P1 through P6) in Study 1.

P1 was the only participant who submitted practice quizzes early in the week and worked on a regular basis—that is, did not procrastinate. In general, P1 submitted one, two, or three practice quizzes per day throughout the study regardless of the condition in effect. P2, P3, and P5, however, changed their studying patterns during the study: They submitted zero, one, or two practice quizzes in the first weeks in both conditions; then they started working regularly and at the beginning of the week (i.e., without procrastinating) in the last 1 or 2 weeks in the contingent condition. P2, P3, and P5 also procrastinated—submitting four to seven practice quizzes on 1 day—in the last weeks in the noncontingent condition. P4 submitted one practice quiz per day during the first 4 days in the

noncontingent condition but then submitted one practice quiz at the beginning of each week in both conditions for the remainder of the study. P6 mainly submitted only one practice quiz per week throughout the study in both conditions, except for one week in which the participant submitted five quizzes on the last day of the week in the noncontingent condition. The results suggest that the contingent schedule of practice quizzes might be responsible for reducing procrastination patterns at the end of the study for three of the five participants who procrastinated (P2, P3, and P5). However, even participants who procrastinated achieved high scores on weekly quizzes (Figure 1).

All participants filled out the social validity questionnaire, with 83% agreeing that practice quizzes helped them prepare for weekly quizzes and that they would like practice quizzes in future classes. Fifty percent of the participants liked the two schedules of practice quizzes equally.

As stated earlier, three of five participants who procrastinated at the beginning of both conditions changed their studying patterns at the end of the contingent condition. This suggests that the contingent schedule of practice quizzes might have encouraged participants to work on a regular basis (i.e., avoid procrastinating). Participants expressed satisfaction with both schedules of practice quizzes; yet, they submitted more practice quizzes in the noncontingent condition.

Study 2

Study 1 showed that the contingent schedule of delivering practice quizzes encouraged some participants to work on a regular basis. Would college students procrastinate less and submit more practice quizzes in the contingent condition if the amount of effort that participants needed to exert when preparing for weekly quizzes was reduced?

The twofold objective of Study 2 was (a) to examine college students' self-regulation and procrastination patterns when preparing for weekly quizzes and (b) to determine if an instructional methodology of providing college students with optional practice quizzes to prepare for weekly quizzes would reduce procrastination and increase their grades if they had to submit two practice quizzes within 2 days to access more practice quizzes.

Method

Participants

Undergraduate students enrolled in an introductory behavior analysis course who had not participated in Study 1 were invited to participate in the study. Thirty-seven students consented to participate, but 18 were excluded because either they did not submit at least one weekly quiz or they did so after the deadline, which might have affected their studying patterns. The other details were similar to those of Study 1.

Setting and materials

Setting and materials were similar to those of Study 1.

Procedure

The procedure was similar to that of Study 1, except for the schedule of delivery of practice quizzes in the contingent and noncontingent conditions.

Contingent condition. The first two optional practice quizzes became available on Thursdays at 12 noon. If a participant submitted the first two practice quizzes, they would have access to two more optional practice quizzes at 12 noon 2 days after the first practice quizzes were made available. If a participant submitted these next two practice quizzes, they would have access to the last optional practice quiz at 12 noon 2 days after the second pair of practice quizzes were made available.

Noncontingent condition. In this condition, the first two practice quizzes became available on Thursdays at 12 noon, the next two on Saturdays at 12 noon, and the last optional practice quiz on Mondays at 12 noon.

Results and Discussion

Figure 3 shows the percentage of correct answers on the pretest and the mean percentage of correct answers on weekly quizzes (columns), as well as the number of practice quizzes submitted in the contingent and noncontingent conditions (data points) per participant. All 19 participants increased their scores from pretest (range, 31% to 60%) to weekly quizzes (posttests). Participants exhibited similar percentages of correct answers in both conditions (range, 84% to 100% in the noncontingent condition and 74% to 100% in the contingent condition). These results support, with more participants, the findings in Study 1 that both schedules of practice led to high scores on weekly quizzes.

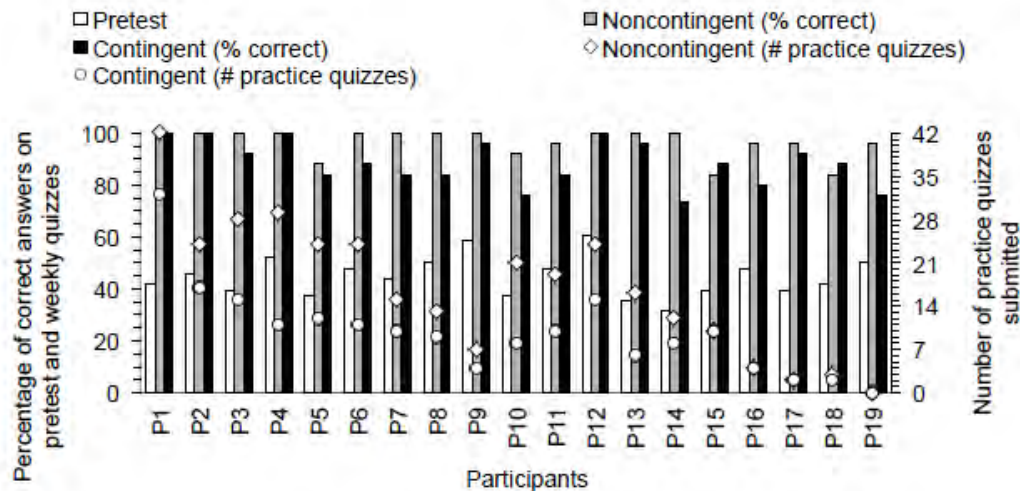


Figure 3. Percentage of correct answers on the pretest and mean percentage of correct answers on the weekly quizzes (columns), and number of practice quizzes submitted (data points) in the contingent and noncontingent conditions across participants (P1 through P19) in Study 2.

In contrast to Study 1, there were more participants (13 in total) who submitted more practice quizzes in the noncontingent condition (P1, P2, P3, P4, P5, P6, P7, P8, P10, P11, P12, P13, and P14) than in the contingent condition. Five participants (P9, P15, P16, P17, and P18) submitted a similar numbers of practice quizzes in both conditions. The remaining participant (P19) did not submit any practice quiz. Similar to in Study 1, these results suggest that the high scores on weekly quizzes might not have been related to the number of practice quizzes submitted.

Figures 4, 5, and 6 present the cumulative number of practice quizzes submitted per day in the noncontingent and contingent conditions. (Note, P16, P17, and P18 submitted one or two practice quizzes in 1 or 2 weeks in each condition, while P19 did not submit any practice quiz; therefore, their performances are not included in any of the cumulative figures).

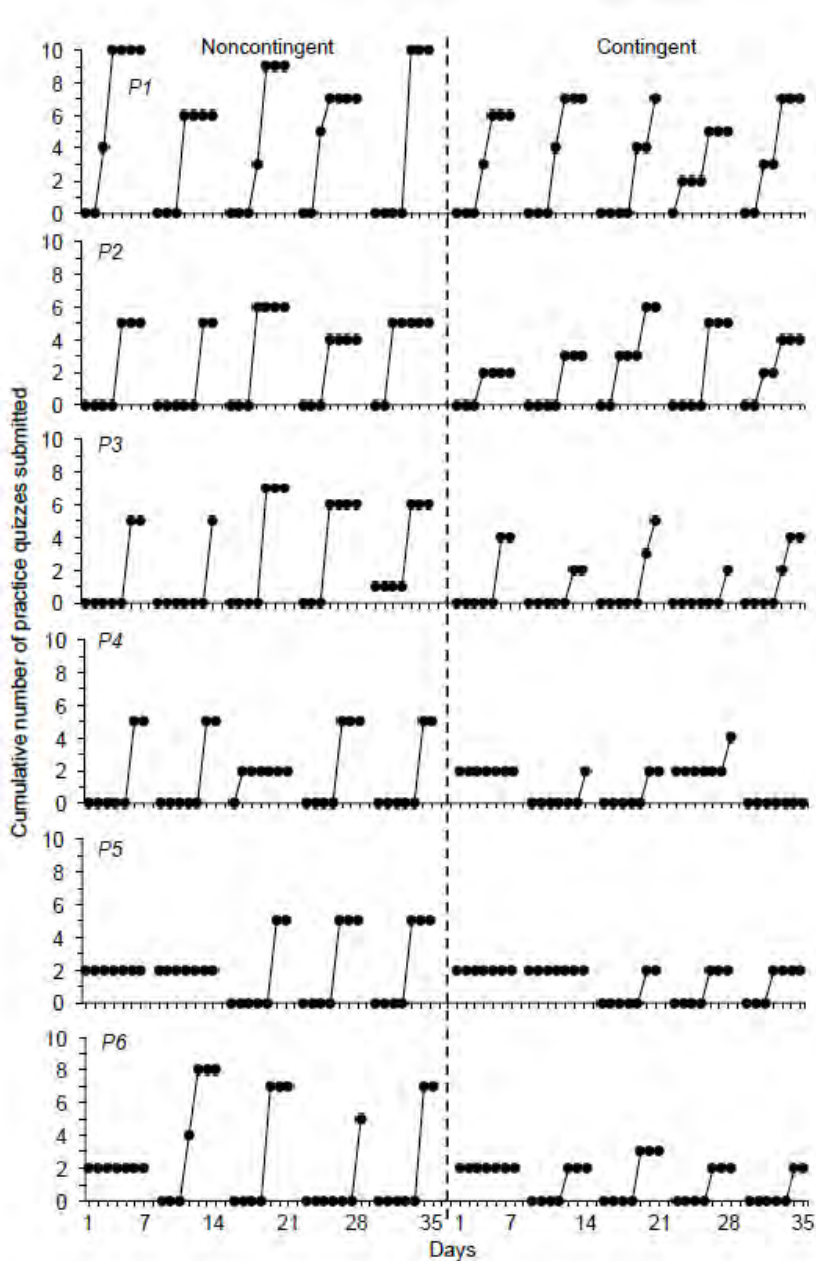


Figure 4. Cumulative number of practice quizzes submitted per day in the noncontingent and contingent conditions for Participants P1, P2, P3, P4, P5, and P6 in Study 2.

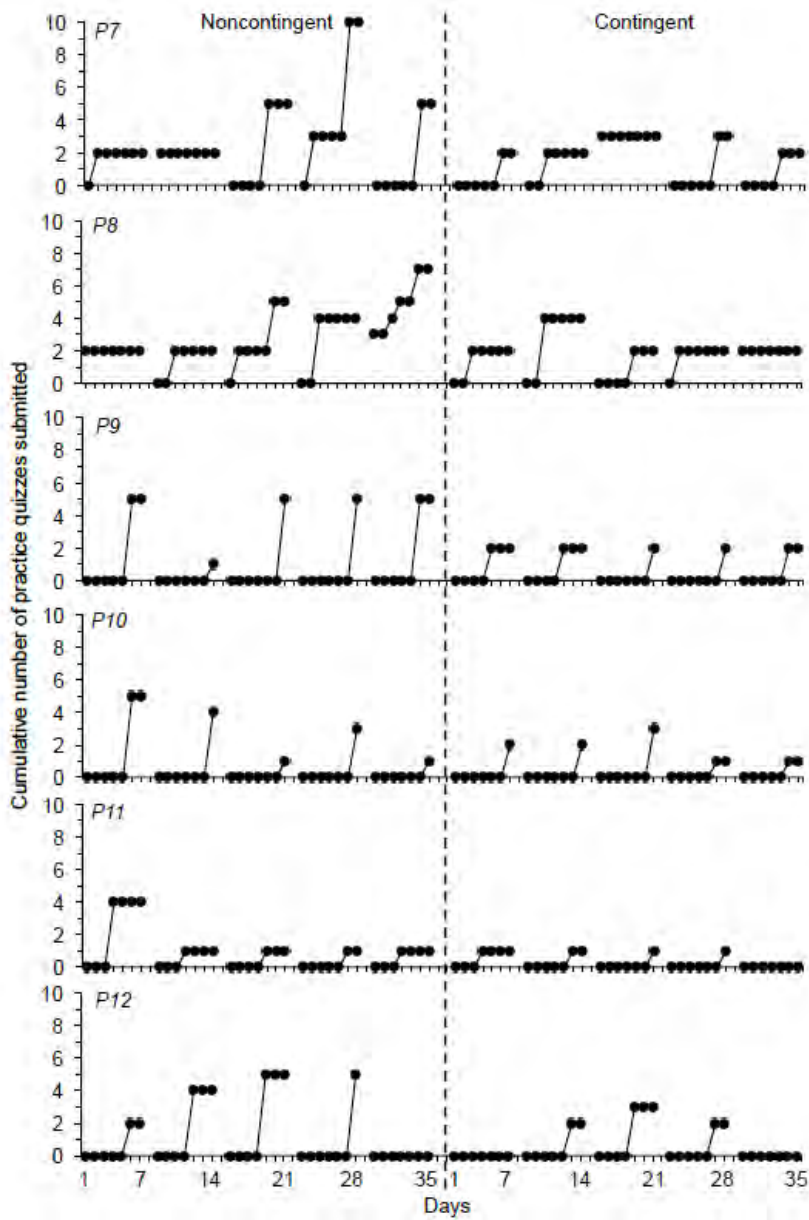


Figure 5. Cumulative number of practice quizzes submitted per day in the noncontingent and contingent conditions for Participants P7, P8, P9, P10, P11, and P12 in Study 2.

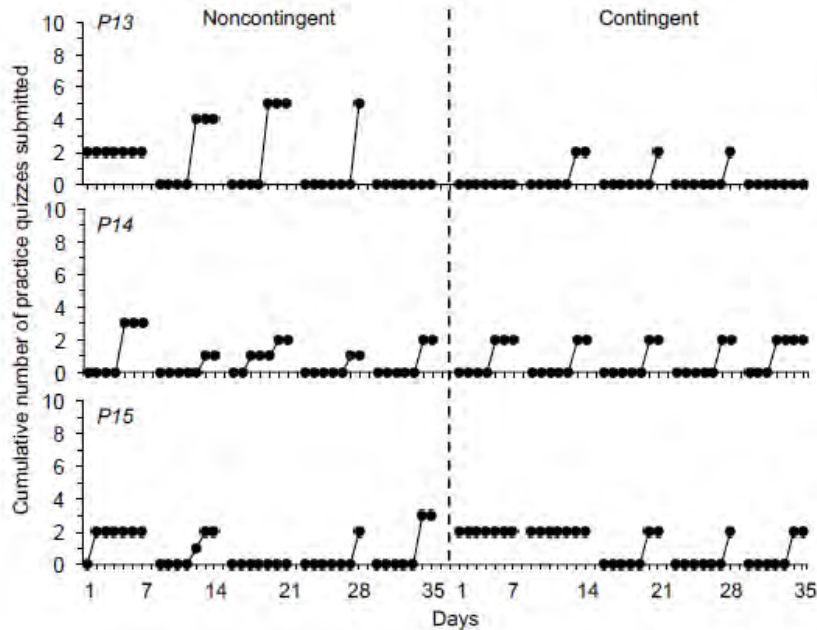


Figure 6. Cumulative number of practice quizzes submitted per day in the noncontingent and contingent conditions for Participants P13, P14, and P15 in Study 2.

P1, P2, and P3 changed their studying patterns during the study: They procrastinated—they submitted 3–10 practice quizzes on 1 day—throughout the noncontingent condition and in the first 2 or 3 weeks in the contingent condition; however, they started working at the beginning of the week and on a regular basis—that is, did not procrastinate—in the last 2 or 3 weeks in the contingent condition according to the contingent schedule of practice quizzes. This finding is similar to that in Study 1 in which three other participants also changed their studying habits and started working on a regular basis at the end of the contingent condition, which suggests that the contingent schedule of delivering practice quizzes might have reduced procrastination patterns at the end of the study. However, P4 through P15 submitted two to seven practice quizzes on 1 day in 1 to 5 weeks in the noncontingent condition. In the contingent condition, the same participants submitted mainly only the first two practice quizzes, available noncontingently at the beginning of the week. As in Study 1, even participants who procrastinated exhibited high scores on weekly quizzes (Figure 3).

Participants' responses on the social validity questionnaire indicate that 97% agreed that practice quizzes were helpful in preparing for weekly quizzes and 94% would like practice quizzes in future classes. In addition, 74% liked both schedules of practice quizzes.

The results from Study 2 support the results from Study 1 on three points. First, the contingent schedule of practice quizzes changed some participants' procrastination patterns at the end of the contingent condition. Second, both noncontingent and contingent conditions yielded high scores on weekly quizzes, even when participants procrastinated. Third, participants reported satisfaction with both schedules of practice quizzes. In contrast to Study 1, in Study 2 most participants submitted more practice quizzes in the noncontingent condition, as opposed to a similar number of practice quizzes submitted in both conditions in Study 1. Study 2 aimed to investigate if college students would submit more practice quizzes if they were required to work on two practice quizzes every 2 days, which could reduce the amount of effort and waiting time to unlock subsequent practice quizzes compared to Study 1. This strategy of delivery of practice quizzes did not seem to encourage more practice quiz submissions or did not reduce procrastination patterns in more students compared to Study 1. In fact,

three participants in each study stopped procrastinating at the end of the contingent condition.

General Discussion

Both studies described here investigated college students' self-regulation and procrastination patterns and strategies to promote self-regulation, reduce procrastination, and increase students' grades when students prepared for weekly quizzes. Study 1 required participants to submit one practice quiz per day every week in the contingent condition, while Study 2 aimed to reduce the amount of effort exerted by the participants by requiring them to submit two practice quizzes every 2 days in the contingent condition. Six participants across both studies changed their procrastination patterns at the end of the contingent condition, which means that they started submitting practice quizzes at the beginning of the week and worked on a regular basis according to the contingent schedule in place.

Although Study 2 attempted to reduce the amount of effort required to submit practice quizzes in the contingent condition, participants submitted more practice quizzes in the noncontingent condition. There are a few possibilities for why this may have happened. First, the noncontingent condition might have reinforced procrastination patterns because participants who waited until the final days to access practice quizzes had access to all practice quizzes. Second, what the researcher considered a decrease in the amount of effort by participants in Study 2 did not work as such. Perhaps having to log into the educational platform and submit practice quizzes every other day still required a relatively high amount of effort by participants that prevented them from submitting more practice quizzes. Third, participants might have realized that they were able to achieve high scores on weekly quizzes by taking a few practice quizzes instead of all of them each week. Fourth, each practice quiz released two new questions compared to the previous practice quiz. This might have made practice quizzes repetitive and punished participants' responses of taking practice quizzes. Exit interviews with participants or a more comprehensive social validity questionnaire addressing these points could help researchers clarify these possibilities and improve the format or method of delivering practice quizzes.

The six participants who stopped procrastinating in both studies did so in the last 2 or 3 weeks in the contingent condition. Had each condition been longer than 5 weeks, perhaps other participants would have changed their procrastination patterns as well. Previous studies have also reported that the lack of observed differences between the treatment and control conditions could be due to the short length of the treatment conditions (Greiner & Karoly, 1976; Mawhinney et al., 1971; Ziesat, Rosenthal, & White, 1978). The alternating-treatment design with 5 weeks in each condition employed here might not have been enough for participants to experience each condition and understand how the conditions worked and affected their performance in the course. Unfortunately, the length of each condition could not be extended further because of the limited time frame within a course and the fact that additions to each condition would have to be implemented in multiples of two to counterbalance the conditions. Future studies should extend the duration of each condition to 6 or 7 weeks, which is feasible in a typical 16-week course. This could be accomplished by removing a few scheduled exams during the course and replacing them with other forms of assessment such as in-class assignments or projects or exams to be completed at home.

Another solution to the alternating-treatment design is to employ other types of within-subject designs, such as a multiple-baseline design (Kazdin, 2011). In a multiple-baseline design, the treatment is introduced at different times, for example, to each participant after a baseline period that varies in length for each participant. Thus, one can look at the effects of the independent variable in one or more participants while another participant is still experiencing the baseline condition. A third possible solution to the relatively short exposure to the treatment conditions is to randomly assign participants to each condition and present one condition to a group of participants first while the remaining participants experience the other condition. Later, participants would switch conditions.

Study 1 was based on the procedure described in Perrin et al. (2011), which reduced procrastination in graduate students and showed that the contingent condition yielded higher quiz scores compared to the noncontingent condition. One reason that might explain the different results between Perrin et al. and the present studies consists of the populations of each work. Perrin et al. had graduate students as participants, a population that might have already learned that rule-governed behaviors (Mallot, 1984), such as using practice quizzes or any supplemental aid offered by their instructors, might be beneficial while college students still need interventions that teach them academic behaviors that help them succeed in college.

Even participants working regularly during the contingent condition did not necessarily achieve higher scores on weekly quizzes as opposed to when they procrastinated in the noncontingent condition. Despite the differences in results from the present studies and previous works (e.g., Ariely & Wertenbroch, 2002; Lloyd & Knutzen, 1969; Mawhinney et al., 1971; Perrin et al., 2011; Wesp, 1989), it is still positive that students performed well even under the noncontingent condition when they procrastinated. From an applied perspective, students were able to maintain high performances despite their procrastination patterns. Nevertheless, the quizzes helped improve students' grades especially because the content and format of the quizzes were similar to those on the exams, which has been empirically supported in the literature (see Glodowski et al., 2019).

The literature on schedules of reinforcement and their subsequent pauses sheds light on the human problem of procrastination. Years of research has revealed that individuals pause—or take a break—after completing the required task in a fixed reinforcement (FR) schedule (Lattal, 1991). An FR schedule means that the individual completes a fixed number of responses to produce the consequence. On the other hand, a variable reinforcement (VR) schedule produces shorter pauses after the completion of the schedule. In this schedule, the number of responses required to produce the consequence varies within a range (Lattal, 1991). The quizzes delivered in the present studies involved an FR schedule since participants had to complete one quiz (i.e., a fixed ratio of 1 or FR 1) within 1 day in Study 1 and two quizzes (i.e., FR 2) within 2 days. That explains the small number of quizzes submitted by the participants on the days that immediately followed the completion of a quiz. Wallace and Mulder (1973) showed that the duration of the pause can be reduced once the schedule is completed if the size of the FR schedule is also reduced. For example, if we were to use the same methods from the current studies, participants would need to submit one quiz every other day. Another possibility is to allow students variable dates between quizzes so they can work on a VR schedule. That could be accomplished by allowing students to commit to the dates they would turn in their work as Ariely and Wertenbroch (2002) did, or the instructor could assign variable periods between quizzes.

Despite decades of studies on procrastination, quite a few questions remain unanswered. The present results show that procrastination patterns can be changed. Nevertheless, we are still unsure what components of a course lead to this change in patterns. As Schlinger et al. (2008) pointed out, researchers and practitioners still do not know what consequences to be provided after students procrastinate are optimal or the extent to which the students' personal history affects their procrastination patterns. For instance, P.E. Johnson et al. (2016) argued that their participants maintained procrastination patterns despite programmed consequences to deter it because failing their other professional or academic obligations was more aversive—and thus yielded more escape behaviors—than failing the course in which the intervention was being investigated. The participants in the present studies likely faced similar urgent professional and personal obligations, since the student population investigated comprised individuals who had to manage schoolwork, employment, and family.

Future studies should explore other paths to help college students that might make procrastination less likely to occur. For instance, future studies should investigate other strategies commonly employed in higher education, such as equivalence-based instruction (EBI). In this field,

custom-built software or learning management systems present the materials, test comprehension, and record participants' performances (e.g., Brodsky & Fienup, 2018; Campos & Hertzberg, 2020). The entire task can be completed in a few minutes even when complex topics are taught. Critchfield (2014) used EBI to teach inferential statistics to college students. In this study, the instructor presented notecards via the university learning management system. Each notecard described the relationship between some concepts, such as a low p value is related to a statistically significant result and the rejection of the null hypothesis while a high p value is related to the result not being statistically significant and the failure to reject the null hypothesis. Students read the notecards describing the relations between the concepts and completed multiple-choice questions to assess their understanding of the readings. Participants learned the concepts using this method. Because of the shorter time (i.e., up to 48 min) compared to the traditional lecture-based education that students receive, it is less likely that students will procrastinate and/or stop working while completing the tasks.

Another feasible alternative to help college students learn is to help them develop self-control. Ziesat et al. (1978) looked at the uses of self-control—stimulus control and self-reward—and self-punishment techniques in college students. In a self-control condition, participants were instructed to choose a study location and use it as the sole location of the study. In a self-rewards condition, participants enjoyed a preferred activity after the completion of a study session. In a self-punishment condition, students pulled a rubber band attached to their wrist every time they procrastinated before starting a study session or if they engaged in any other activity during a study session. Compared with a control group, participants in the treatment groups studied for longer periods while decreasing their reported problems with studying. Nevertheless, there were no differences among the treatment conditions—stimulus control and self-reward.

Participants in the present studies reported satisfaction with both schedules of practice quizzes, yet they submitted more practice quizzes in the noncontingent condition. This result aligns with a vast literature on differences between what participants state in explicit measures, such as during interviews or on questionnaires, and what participants do on implicit tasks, such as response latency on computer tasks (e.g., Barnes-Holmes et al., 2006). Nevertheless, the social validity questionnaire is a necessary element included in most studies in applied behavior analysis that aim to improve people's lives (Baer et al., 1968) and, therefore, should include procedures and strategies acknowledged by users of these procedures and strategies.

As stated by P.E. Johnson et al. (2016) and Perrin et al. (2011), studies that attempt to evaluate, measure, and reduce procrastination contribute to an understanding of how students acquire knowledge in college and how such skills might generalize to other contexts. This is especially important because students will soon graduate and face real-world problems where professors are no longer around to guide them. Hence, developing self-regulations skills in college students through the reduction of procrastination might lead to more productive and self-managed individuals later in life.

Appendix

Appendix 1. Social Validity Questionnaire.

Practice quizzes were helpful in preparing for weekly quizzes.

1	2	3	4	5
Disagree	Disagree somewhat	Neutral	Agree somewhat	Agree

I prefer practice quizzes to other means of studying.

1	2	3	4	5
Disagree	Disagree somewhat	Neutral	Agree somewhat	Agree

I believe practice quizzes added to my preparedness for weekly quizzes.

1	2	3	4	5
Disagree	Disagree somewhat	Neutral	Agree somewhat	Agree

I liked each schedule of practice quiz access.

1	2	3	4	5
Disagree	Disagree somewhat	Neutral	Agree somewhat	Agree

I would like practice quizzes in future classes.

1	2	3	4	5
Disagree	Disagree somewhat	Neutral	Agree somewhat	Agree

I printed practice quizzes for offline use.

1	2	3	4	5
Disagree	Disagree somewhat	Neutral	Agree somewhat	Agree

I used practice quizzes and other means of studying.

1	2	3	4	5
Disagree	Disagree somewhat	Neutral	Agree somewhat	Agree

Which course components would you suggest continuing?

Which course components would you suggest discontinuing?

References

- Ariely, D., & Wertenbroch, K. (2002). Procrastination, deadlines, and performance: Self-control by precommitment. *Psychological Science, 13*(3), 219–224. <https://doi.org/10.1111/1467-9280.00441>
- Baer, D. M., Wolf, M. M., & Risley, T. R. (1968). Some current dimensions of applied behavior analysis. *Journal of Applied Behavior Analysis, 1*(1), 91–97. <https://doi.org/10.1901/jaba.1968.1-91>
- Barnes-Holmes, D., Barnes-Holmes, Y., Power, P., Hayden, E., Milne, R., & Stewart, I. (2006). Do you really know what you believe? Developing the Implicit Relational Assessment Procedure (IRAP) as a direct measure of implicit beliefs. *The Irish Psychologist, 32*, 1–38.
- Brodsky, J. & Fienup, D. M. (2018). Sidman goes to college: A meta-analysis of equivalence-based instruction in higher education. *Perspectives on Behavior Science, 41*, 95–119. <https://doi.org/10.1007/s40614-018-0150-0>
- Campos, H. C., & Hertzberg, H. (2020). Effects of note card training and selection-based instruction via Blackboard on topographical responding with college students. *Education, 140*(3), 154–164.
- Critchfield, T. S. (2014). Online equivalence-based instruction about statistical inference using written explanation instead of match-to-sample training. *Journal of Applied Behavior Analysis, 47*, 606–611. <https://doi.org/10.1002/jaba.150>
- Glodowski, K. R., Thompson, R. H., & Asuncion, E. A. (2019). Evidence-based recommendations for programming quizzes to improve college student behavior in residential courses. *Journal of Behavioral Education, 165*–172. <https://doi.org/10.1007/s10864-019-09330-z>
- Greiner, J. M., & Karoly, P. (1976). Effects of self-control training on study activity and academic performance: An analysis of self-monitoring, self-reward, and systematic planning components. *Journal of Counseling Psychology, 23*, 495–502. <https://doi.org/10.1037/0022-0167.23.6.495>
- Haggas, A. M., & Hantula, D. A. (2002). Think or click? Student preference for overt vs. covert responding in web-based instruction. *Computers in Human Behavior, 18*, 165–172. [https://doi.org/10.1016/S0747-5632\(01\)00041-3](https://doi.org/10.1016/S0747-5632(01)00041-3)
- Harris, V. W., & Sherman, J. A. (1974). Homework assignments, consequences, and classroom performance in social studies and mathematics. *Journal of Applied Behavior Analysis, 7*, 505–519. <https://doi.org/10.1901/jaba.1974.7-505>
- Jarmolowicz, D. P., Hayashi, Y., & Pipkin, C. S. P. (2010). Temporal patterns of behavior from the scheduling of psychology quizzes. *Journal of Applied Behavior Analysis, 43*, 297–301. <https://doi.org/10.1901/jaba.2010.43-297>
- Johnson, K., & Ruskin, R. (1977). *Behavioral instruction: An evaluative review*. Washington, DC: American Psychological Association.
- Johnson, P. E., Jr., Perrin, C. J., Salo, A., Deschaine, E., & Johnson, B. (2016). Use of an explicit rule decreases procrastination in university students. *Journal of Applied Behavior Analysis, 49*, 1–13. <http://doi.org/10.1002/jaba.287>
- Kazdin, A. E. (2011). *Single-case research designs: Methods for clinical and applied settings* (2nd ed.). Oxford University Press.
- Keller, F. S. (1968). “Good-bye, teacher...” *Journal of Applied Behavior Analysis, 1*, 79–89. <https://doi.org/10.1901/jaba.1968.1-79>
- Lattal, K. A. (1991). Scheduling positive reinforcers. In I. H. Iversen & L. A. Lattal (Eds.), *Experimental analysis of behavior* (pp. 87–134). Elsevier.
- Lloyd, K. E., & Knutzen, N. J. (1969) A self-paced programmed undergraduate course in the

- experimental analysis of behavior. *Journal of Applied Behavior Analysis*, 2, 125–133.
<http://doi.org/10.1901/jaba.1969.2-125>
- Mallot, R. (1984). Rule-governed behavior, self-management, and the developmentally disabled: A theoretical analysis. *Analysis and Intervention in Developmental Disabilities*, 4, 199–209.
[https://doi.org/10.1016/0270-4684\(84\)90041-7](https://doi.org/10.1016/0270-4684(84)90041-7)
- Mawhinney, V. T., Bostow, D. E., Laws, D. R., Blumenfeld, G. J., & Hopkins, B. L. (1971). A comparison of students studying-behavior produced by daily, weekly, and three-week testing schedules. *Journal of Applied Behavior Analysis*, 4, 257–264.
<https://doi.org/10.1901/jaba.1971.4-257>
- Michael, J. (1991). A behavioral perspective on college teaching. *The Behavior Analyst*, 14, 229–239.
<https://doi.org/10.1007/bf03392578>
- Muraven, M., Baumeister, R. F., & Tice, D. M. (1999). Longitudinal improvement of self-regulation through practice: Building self-control strength through repeated exercise. *The Journal of Social Psychology*, 139(4), 446–457. <https://doi.org/10.1080/00224549909598404>
- Olympia, D. E., Sheridan, S. M., Jenson, W. R., & Andrews, D. (1994). Using student-managed interventions to increase homework completion and accuracy. *Journal of Applied Behavior Analysis*, 127, 85–99. <https://doi.org/10.1901/jaba.1994.27-85>
- Perrin, C. J., Miller, N., Haberlin, A. T., Ivy, J. W., Meindl, J. N., & Neef, N. A. (2011). Measuring and reducing college students' procrastination. *Journal of Applied Behavior Analysis*, 44, 463–474.
<https://doi.org/10.1901/jaba.2011.44-463>
- Reiser, R. A. (1984). Reducing student procrastination in a personalized system of instruction course. *Educational Communication and Technology Journal*, 32, 41–49.
<https://doi.org/10.1007/BF02768768>
- Schlinger, H. D., Derenne, A., & Baron, A. (2008). What 50 years of research tell us about pausing under ratio schedules of reinforcement. *The Behavior Analyst*, 31, 39–60.
- Semb, G., Hopkins, B. L., & Hursh, D. E. (1973). The effects of study questions and grades on student test performance in a college course. *Journal of Applied Behavior Analysis*, 61, 631–642.
<https://doi.org/10.1901/jaba.1973.6-631>
- Sidman, M. (1989). *Coercion and its fallout*. Authors Cooperative.
- Wallace, R. F., & Mulder, D. W. (1973). Fixed-ratio responding with human subjects. *Bulletin of the Psychonomic Society*, 1, 359–362.
- Wesp, R. (1986). Reducing procrastination through required course involvement. *Teaching of Psychology*, 13, 128–130. https://doi.org/10.1207/s15328023top1303_6
- Ziesat, H. A., Rosenthal, T. L., & White, G. M. (1978). Behavioral self-control in treating procrastination of studying. *Psychological Reports*, 42, 59–69.
<https://doi.org/10.2466/pr0.1978.42.1.59>