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Improved Self-Control: The Benefits of a Regular Program of Academic Study

Megan Oaten and Ken Cheng
Macquarie University, Sydney

Academic examination stress impairs regulatory behavior by consuming self-control strength (Oaten & Cheng, 2005). In this study, we tested whether a study intervention program, a form of repeated practice of self-control, could improve regulatory strength and dampen the debilitating effects of exam stress. We assessed 2 cohorts at baseline and again at the commencement of exams. Without any intervention, we replicated our previous findings of deteriorations in regulatory behaviors at exam time. Students receiving the study program, however, showed significant improvement in self-regulatory capacity as shown by an enhanced performance on a visual tracking task following a thought-suppression task. During examinations, these participants also reported significant decreases in smoking, alcohol, and caffeine consumption and an increase in healthy eating, emotional control, maintenance of household chores, attendance to commitments, monitoring of spending, and an improvement in study habits. Hence, the study program not only overcame deficits caused by exam stress but actually led to improvements in self-control even during exam time.

Self-regulation or *self-control* (terms used interchangeably here) can be defined as the capacity to enact control over one's behavior. Self-control is needed to override dominant behaviors that may be self-destructive, irrational, or undesirable in the long term. Examples of typical self-control problems include not exercising enough, engaging in unsafe sexual practices, abusing drugs and alcohol, overspending, and not sticking to study schedules.

Our goals in this study were to (a) replicate the finding that real world stress, specifically academic examinations, consume self-control strength and consequently produce impairments in a number of unrelated regulatory behaviors (Oaten & Cheng, 2005a), and (b) test whether the repeated practice of self-control (a study intervention program) could improve regulatory strength and make students less vulnerable to the debilitating effects of periods of high academic demand.

RESOURCE MODEL OF SELF-CONTROL

A recent model suggests a lack of self-regulatory resources as one reason why self-regulation might fail (Baumeister, Heatherton, & Tice, 1994; Muraven, Tice, & Baumeister, 1998). The resource model considers self-control to operate like a muscle. Any act of self-control tires this muscle, leaving less available strength for subsequent self-control tasks. This muscle is considered to fatigue easily, as all acts of self-control have been argued to draw on a common resource or regulatory strength that is of limited capacity and is therefore readily depleted. This aspect of the model is well established, with evidence to suggest that in the short term, people's capacity for self-control diminishes following exertion much like muscular action. For example, when individuals were asked to engage in tasks involving self-regulation, the ability to self-regulate in subsequent activities significantly declined (Muraven et al., 1998; Vohs & Heatherton, 2000; Vohs & Schmeichel, 2003). This effect of depletion has been reported across a variety of tasks in physical, intellectual, and emotional domains.

ACADEMIC STRESS AND SELF-CONTROL FAILURE

Failures of self-control may be related to experienced stress. A disturbing trend in student health is the reported increase in student stress internationally (Sax, 1997; Cotton, Dollard, & de Jonge, 2002). Students report experiencing academic stress at predictable times each semester, with the greatest

Correspondence should be addressed to Megan Oaten, Department of Psychology, Macquarie University, Sydney, New South Wales, Australia 2109. E-mail: [redacted]

sources of academic stress resulting from studying for and taking exams, grade competition, and the large amount of course content to master in a small amount of time (Archer & Lamnin, 1985; Britton & Tesser, 1991; Kohen & Fraser, 1986). Examination periods have been used to investigate a number of stress responses. A finding that surfaces in these studies is that many forms of self-regulation break down when people are managing stress. For example, West and Lennox (1992) reported that smoking level among students was higher immediately preceding exams than at a more neutral period. Cartwright et al. (2003) revealed that greater academic stress was associated with more fatty food intake, less fruit and vegetable intake, more snacking, and a reduced likelihood of daily breakfast consumption. Recent longitudinal research has found that academic examination stress was associated with increases in cigarette smoking and decreases in physical activity (Steptoe, Wardle, Pollard, Canaan, & Davies, 1996).

In a previous study (Oaten & Cheng, 2005a), we tested whether at stressful times (during examination periods) people fail at self-regulation in domains in which control has previously been successful (e.g., diet). We found that students at exam time reported breakdowns in regulatory behavior that were not found in a control group. We found this effect in both a laboratory task (Stroop Test; Stroop, 1935) and on a range of self-reported day-to-day behaviors. Performance on the Stroop Test deteriorated following thought suppression, a form of regulatory activity, during the examination period. Outside of the examination period, no such effect due to thought suppression was evident. Exam time also proved detrimental to a number of other self-control operations. During the examination period, students reported an increase in smoking and caffeine consumption; a decrease in healthy dietary habits, emotional control, frequency and duration of physical activity, maintenance of household chores and self-care habits, attendance to commitments, and monitoring of spending; and deterioration of sleep patterns and study habits.

In light of the resource model of self-control, our interpretation of the link between exam stress and self-control failure is that managing stress requires self-regulation and thus depletes limited regulatory resources. An important part of the body's defenses for coping with stress is the "fight-or-flight" response. The fight-or-flight response prepares people for physical, emotional, and mental action and is considered essential for survival (Selye, 1956). These fight-or-flight responses, however, can be counterproductive when dealing with the stresses of modern life such as academic examinations (Zillman, 1983). People therefore require self-regulation to override these natural responses to substitute other, quite unnatural responses (such as studying harder) in their place.

Stress regulation may also involve processes that demand inhibition, such as ignoring sensations, overriding negative thoughts, and suppressing emotions (Wegner & Pennebaker, 1993) as well as regulating attention (Hockey, 1984). Glass, Singer, and Friedman (1969) found that there is a "psychic cost" of controlling stress such that this cost is reflected in a reduced capacity to regulate task performance following an external stressor (unpleasant electric shock or unpredictable noise). Glass et al.'s (1969) findings that performance is impaired following stressors have been replicated many times using measures of frustration tolerance (Glass & Singer, 1972), proofreading (Gardner, 1978; Glass & Singer, 1972), and the Stroop Task (Glass & Singer, 1972). These tasks all required the individual to override a dominant response, thus requiring self-control (Muraven & Baumeister, 2000). It seems that the work required to control stress leaves the individual less able to regulate behavior successfully. Poorer self-control is a consequence of previous attempts to regulate stress.

SELF-REGULATORY IMPROVEMENT

Thus, artificial laboratory tasks of self-regulation and having to deal with the stress of examination both lead to poorer self-control. These findings support one important aspect of the resource model: depletion. In addition, the resource model makes a second prediction: Self-control should also become stronger with repeated practice, and such strengthening may provide a strategy to counter regulatory failure.

Previous research has found that the repeated practice of self-control was followed by increments in self-control performance (Muraven, Baumeister, & Tice, 1999; Oaten & Cheng, 2005b; Oaten, Cheng, & Baumeister, 2003). In the study with the longest duration, the uptake and maintenance of an exercise program over a 2-month period produced significant improvements in a wide range of regulatory behaviors (Oaten & Cheng, 2005b). Improvements were found in a laboratory task (visual tracking under distraction, which is used in this study as well) and on many self-reported everyday behaviors. The laboratory measure and the self-reported behaviors bore no resemblance to the exercise program other than that they all involved self-regulation. In particular, individuals who participated in the exercise program demonstrated better self-regulation in other spheres: related (e.g., they engaged in more healthy behaviors), unrelated (e.g., missed fewer appointments), and laboratory based (visual tracking task [VTT]).

There are two ways in which self-control strength could be improved. These are consistent with the ways in which muscular strength can be increased: power (an increase in the simple baseline capacity) and stamina (a reduction in vulnerability to fatigue). Muraven et al. (1999), Oaten et al. (2003), and Oaten and Cheng (2005b) found evidence for increased stamina. The self-regulatory training appears to make people less vulnerable to the effects of resource depletion.

THIS RESEARCH

In this study, we examined how students fared in the examination period after they had been partaking in a regular study

TABLE 1
Timeline for Study Program

Time	Semester 1		Semester Break		Semester 2	
	Baseline	*Exams*	*Control Baseline*	*Control Follow-up*	*Baseline*	*Exams*
Cohort	SP	SP				
Cohort 2	WL	WL	C	C	SP	SP

Note. SP = intervention phase (study program); WL = no-intervention phase (waiting list control); C = control phase (non-stressful testing sessions.

program. In the experimental design, two cohorts participated in the study intervention program (Table 1) at different times of the academic year. Cohort 1 entered the study intervention program directly; they were tested twice across Semester 1 (baseline, exams). Cohort 2 was tested across a time span that included parallel testing sessions to Cohort 1 during Semester 1 (waiting-list control). Cohort 2 then entered a control phase that included two assessments of self-regulatory behavior (baseline, follow-up) during the semester break, which provided a neutral period of academic demand. The control phase tests whether any obtained findings were the result of repeated testing and provides measures of retest reliability. Finally, Cohort 2 entered the study intervention program in Semester 2.

Cigarette smoking, alcohol consumption, and caffeine consumption are some of the behaviors included in this study. Cigarettes, alcohol, and caffeine are the most widely used psychoactive substances in the world (Nehlig, 1999). Despite differing levels of social acceptability, these behaviors are all considered addictive (Stepney, 1996) and therefore require some level of regulatory management (Mumford, Neill, & Holtzman, 1988). The other regulatory behaviors of interest are diet, physical activity, self-care habits such as household chores, emotional control, study habits, spending habits, and time management. If managing the stress of examinations does deplete regulatory resources, and the repeated practice of self-control does improve regulatory capacity, then we would expect (a) maintenance or even improvement in regulatory behavior at exam time for those people participating in the intervention phase (study program), (b) impairment in regulatory behavior for those people in the no-intervention phase (waiting-list control) during exam time, and (c) no change in regulatory behavior across the control phase (nonstressful testing sessions).

We were also interested in finding out whether academic stress affects self-control performance on a standard laboratory task. We used visual tracking under distraction, which requires participants to perform a computerized VTT while a distracter video is played simultaneously at a loud volume. The VTT requires participants to track the movement of multiple independent targets displayed on a computer monitor (Pylyshyn & Storm, 1988; Scholl, Pylyshyn, & Feldman, 2001). The participant must ignore the distracter video content and attend only to the VTT. In a recent set of studies, VTT performance deteriorated only when following tasks that required some form of regulatory exertion—in particular, a thought-regulation task (Oaten & Cheng, 2005b) or emotion regulation (Oaten, Chau, & Cheng, 2005)—but was unaffected when following tasks that did not require self-control (watching humorous videos; Oaten et al., 2005). Thus, this task is sensitive to depletion manipulations but not to nondepleting intervening tasks. In this study, we administered the VTT twice at each session, and in between VTT testings, participants were told to control their thoughts by not thinking about a white bear. This is a standard manipulation of regulatory depletion used in past research (Muraven et al., 1998). Our (Oaten & Cheng, 2005b) previous research has found that performance on the VTT is highly sensitive to an intervening thought-suppression task, performance being worse after 5 min of thought suppression. A program of regular physical exercise, however, alleviated the adverse effect of the thought-suppression task on the VTT. We were therefore interested in finding out whether a study intervention program would have similar effects. We predicted similar performance on the VTT before thought suppression in all conditions. After thought suppression, however, performance on the VTT should be most impaired in participants tested at exam time without intervention (waiting-list control), next most impaired in participants tested during nonstressful times (control), and least impaired in participants who had partaken the study intervention program (study program).

METHOD

Participants

A total of 45 Macquarie University undergraduates (7 men and 38 women) recruited from introductory psychology courses participated in return for partial fulfillment of a course requirement. The age of participants ranged from 18 to 51 years, with a mean age of 23 years.

We randomly assigned participants to one of two cohorts (Cohorts 1 and 2). Cohort 1 ($n = 28$; 4 men and 24 women) entered the study intervention phase directly and was individually tested in 2- to 30-min sessions separated by 8-week interim periods. Cohort 2 ($n = 17$; 3 men and 14 women) first entered the no-intervention phase (wait-list control) and then

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provided general controls (control phase) before proceeding to the study intervention phase and were individually tested in 6- to 30-min sessions separated by 8-week interim periods.

Design

Table 1 shows the schedule of testing for the two cohorts. Cohort 1 entered the intervention phase (study program) directly. We obtained baseline measures for Cohort 1 in Week 5 of Semester 1, the commencement of the study program, and then again during the exam period for that semester. Cohort 2 entered the no-intervention phase (waiting-list control) in Semester 1 with no study program. Parallel to Cohort 1, we obtained baseline measures for Cohort 2 in Week 5 and then again during the exam period. Cohort 2 entered the intervention phase (study program) in Semester 2. We again obtained baseline measures in Week 5, at the commencement of the study program, and then during the exam period. Cohort 2 also provided general controls by participating in two testing sessions (baseline, follow-up) occurring during nonstressful times. This served as within-subjects and between-subject control for the effects of the study program. All testing sessions were uniform. Experimental sessions were separated by 8-week periods.

We tailored study programs to suit each participant's student workload and included the provision of a study register (log of hours spent studying, which was submitted to us in testing sessions), study diary (which was also submitted in experimental sessions), artificial early deadlines, and a study schedule for the examination period. We give more details following.

We analyzed each experimental phase (intervention, no-intervention, and control) separately using a more conservative alpha value of .01 for all statistical tests due to repeated analysis of the same participants.

Study Program

Participants were instructed to bring both their student timetable (i.e., a schedule of class contact hours) and assessment timetable (due dates for coursework assessments) to the initial testing session. We discussed with the participants any work commitments that needed to be incorporated into the study program.

Artificial early deadlines. Self-imposed deadlines are a popular strategy used by many in attempts to curb procrastination (Tice & Baumeister, 1997). In fact, recent research suggested that external deadlines are more effective than self-imposed deadlines in boosting task performance (Ariely & Wertenbroch, 2002). We therefore imposed early artificial deadlines on participants' assessment schedules. The artificial deadlines required the breaking down of the distant goal into several proximal, specific, clear, achievable goals, thus making participants aware of their own concrete progress, which was required to maintain their long-term engagement with the program (Schunk, 1995; Zimmerman, 1989).

Study schedule. The study schedule provided a temporal plan for studying in the lead up to examinations. The study schedule specified all of the available dates and times during that specific semester (taking into consideration university contact hours and any specified work commitments), along with a "suggested" study task designated to a specific date(s). We administered the study schedule so as to enable participants to detect and react to any discrepancies resulting from the comparison of their current level of study and final study goal state over the course of the semester. Students were expected to (a) gradually increase awareness to these suggested versus enacted discrepancies and (b) learn to modify their behaviors so as to reduce incongruities, thus enhancing self-regulation and improving performance.

Study register and study diary. These tools provided opportunities for students to monitor themselves and to generate the feedback necessary for self-regulation. *Self-monitoring* refers to the activities involved in observing and recording one's own behavior (Mace, Belfiore, & Shea, 1989). Feedback is generated by a perceived discrepancy between the outcome state (in this case, the study goal) and the current state regarding the task. This feedback fosters attempts to reduce any disparity by changing plans, tactics, or strategies; modifying aspects of their goals; or even abandoning the task (Butler & Winne, 1995). Participants' utilization of these tools was expected to reveal their planning process and their awareness of various cues while monitoring.

Manipulation Checks

We employed the study register and study diaries as manipulation checks to ensure that participants were adhering to the study program.

Study register. Average study time was assessed by having participants complete a study register (a log of the time spent studying) throughout the no-intervention (waiting-list control) and intervention (study program) phases. For analyses, *study time* was defined as the total number of hours, on average, that participants studied per week.

Study diaries. To assess ease of uptake and maintenance of the study program, we employed the use of study diaries. As part of their diary logs, participants were asked the following questions: "What level of difficulty, if any, have you experienced complying with the program?"; "Do you feel your study habits are improving with the program?"; and "Do you wish to comment on the program generally?". Participants were instructed to record their progress in the diaries provided and to return them to the experimenter at each experimental session.

Psychosocial Self-Reports

The General Health Questionnaire (GHQ; Goldberg, 1972). We assessed emotional distress in all sessions using the 28-item version of the GHQ. This measure assesses symptoms of emotional distress in four areas: anxiety/insomnia, somatic symptoms, social and cognitive dysfunction, and depression. The questionnaire referred to respondents' experiences over the past week and was coded using a method that assigns weights of 0, 1, 2 and 3 to each answer option. The GHQ has a high degree of internal consistency, with a reported Cronbach alpha of .87, and retest reliability was reported as .88 (Goldberg, 1972).

Perceived Stress Scale (PSS; Cohen, Kamarck, & Mermelstein, 1983). We measured perceived stress in all sessions using the 10-item version of the PSS. We used the PSS to assess the degree to which situations in life are appraised as stressful. Each item (e.g., "In the last week, how often have you felt that things were going your way?") was assessed on a 5-point scale ranging from 0 (*never*) to 4 (*very often*), with higher scores indicating greater stress. The PSS has been shown to be very useful to assess perceived stress, with an overall Cronbach alpha of .87, and retest reliability was reported as .85 (Cohen et al., 1983). This measure has also been used in studies of academic examination stress (Steptoe et al., 1996; Oaten & Cheng, 2005a).

General Self-Efficacy Scale (GSES; Jerusalem & Schwarzer, 1992). We measured self-efficacy in all sessions using the 10-item version of the GSES. Each item (e.g., "It is easy for me to stick to my aims and accomplish my goals") was assessed on a 5-point scale ranging from 0 (*not at all true*) to 4 (*very true*), with higher scores indicating higher perceived self-efficacy. The scale has been used in numerous research projects in which it has typically yielded internal consistencies between $\alpha = .76$ and .91. Its stability is satisfactory, with retest reliability reported as .75 (Jerusalem & Schwarzer, 1992).

Behavioral Self-Reports

We designed a questionnaire to assess cigarette smoking, alcohol and caffeine consumption, physical activity, dietary habits, and other regulatory behavior. We administered the questionnaire in both sessions. The test–retest reliability of the questionnaire is reported in the Results.

Chemical consumption. We assessed cigarette smoking, caffeine consumption, and alcohol consumption by the use of open-ended questions presented in a questionnaire format. We estimated current cigarette smoking as the number of cigarettes smoked over the past 24 hr. We assessed current alcohol consumption using a 7-day recall procedure in which quantity of alcoholic beverage was recorded. We also assessed caffeine consumption using a 7-day recall procedure, with quantity being the measure of interest.

Dietary habits. We assessed dietary habits by questioning participants about food choice (e.g., "In the last week, how successfully did you maintain a healthy diet?") and dietary restraint (e.g., "In the last week, how often did you eat junk food?") over the past week. Response sets were recorded on a 5-point scale ranging from 0 (*never*) to 4 (*more than once per day*). We derived 2 measures for analysis: junk food and healthy eating.

Physical activity. We measured exercise by questioning participants about the frequency and duration of physical activity sessions over the past week. Response sets were recorded on a 5-point scale ranging from 0 (*never*) to 4 (*more than once per day*). We derived 2 measures for analysis: the number of episodes of physical activity and the total duration of physical activity sessions.

General regulatory behavior. We measured various everyday behaviors that involve self-control (e.g., "In the last week, how often did you go out with friends instead of studying?"). We aimed to include those behaviors that do not serve a stress-relieving function. We recorded response sets on a 5-point scale ranging from 0 (*never*) to 4 (*more than once per day*). We derived nine measures for analysis: self-care habits (laundry habits, leaving dishes in the sink), time management (keeping appointments and procrastination), study habits (spending time with friends instead of studying and watching television instead of studying), spending habits (spending without thinking and overspending), and emotional control (loss of temper).

Visual Tracking Under Distraction

We gave a laboratory task of self-control twice in each test session. Participants performed a VTT while a distracter video played at the same time in the forefront of the participant. We instructed the participant to ignore the distracter video content and attend only to the VTT. The VTT requires participants to visually track the movement of multiple targets displayed on a computer monitor (see Figure 1). The distracter video included excerpts from a comedy routine by Eddie Murphy (Murphy, Tieken, & Wachs, 1983). The use of the VTT to assess self-regulatory capacity has been validated in previous research (Oaten and Cheng, 2005b; Oaten, et al., 2005), and we selected it for that reason.

Stimuli were displayed on an I-Mac® computer equipped with a 15-in. monitor set to a resolution of 800 × 600 pixels

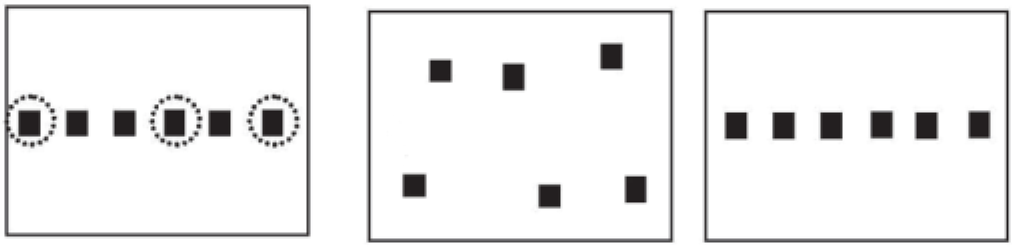

FIGURE 1 A representation of a visual tracking task experimental sequence. Participants view items on computer monitor. In the target identification phase (Step 1), six cubes appear on the screen, and three of them flash briefly to indicate that they are the targets; then all squares move randomly (Step 2). The task of the participant is to select the three targets once they have stopped moving by placing the cursor on them and clicking with the mouse (Step 3).

and a refresh rate of 95 Hz. Participants were seated 54 cm away from the monitor. We controlled and measured the VTT using Psyscript (Version 4; Bates & D'Oliviero, 2000). Each VTT consisted of 16 trials. At the beginning of each trial, six black squares (20 × 20 mm) were presented in a horizontal line. After 2 sec, three target items were highlighted with small blinking probes (disappearing and reappearing for five flashes). Then all items moved in random trajectories for 5 sec. After all of the objects stopped moving, the participant had to indicate the three target items using the mouse. The final mouse click caused the display to disappear, and the participant initiated the next trial with a key press.

Forty-eight sets of trajectories (along with target selections) were generated and stored offline. Participants completed a practice trial for which the data were not collected and then completed the experimental trials in a randomized order (different for each participant).

Thought Suppression Task

Following the first assessment of self-regulatory performance, we administered a thought suppression task to manipulate regulatory exertion. The procedure, developed by Wegner, Schneider, Carter, and White (1987), requires the participant not to think about a white bear. This task has been used previously to manipulate self-regulatory depletion (Muraven et al., 1999, 1998). We told participants that over the course of the experiment, they would be asked to perform a cognitive task (thought suppression). We instructed participants to write down all their thoughts on a piece of paper for 5 min, one thought per line, so that we could "see how you use words in naturally occurring sentences" (Muraven et al., 1998). We then administered the experimental manipulation. We instructed participants to list any thoughts that came to mind with the caution that they should avoid thinking about a white bear. We told participants that whenever they thought of a white bear, they were to write that thought down. We emphasized that it was critical to change their thoughts immediately and to try not to think of a white bear again. Following the thought suppression task, we recorded a follow-up measure of self-regulatory performance by administering a second VTT.

Procedure

Testing procedure was uniform across sessions. Participants first signed experimental consent forms and we then administered in order a VTT, the thought suppression task, and then a second VTT. We then obtained measures of emotional distress, perceived stress, perceived self-efficacy, and general regulatory behaviors. We conducted data collection between Tuesday and Friday of each week so that all smoking information related to a weekday.

RESULTS

Overall, 9 (24%) women and 2 (28%) men smoked at some point throughout the testing session; 17 (45%) women and 4 (57%) men consumed caffeine; and 21 (55%) women and 4 (57%) men consumed alcohol. The numbers that engaged in regular physical activity included 32 (84%) women and 7 (100%) men. There was no significant difference between genders in the proportions carrying out these behaviors and no baseline differences between the exam-stress and control groups. We restricted analyses of each behavior to those individuals who engaged in these activities rather than the entire sample.

Manipulation Checks

Study register. The study register (log of hours spent studying) indicated that participants did adhere to the study program. Figure 2 summarizes the mean hours spent studying. Cohort 2 was the only cohort to participate in the no-intervention phase (waiting-list control) and was therefore the only cohort included in the following analyses. The reported average number of hours spent studying were entered into a session (baseline, exams) repeated measures analysis of variance (ANOVA). The ANOVA showed no effect of session

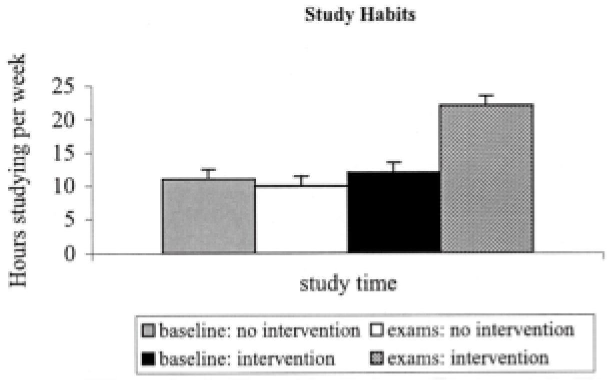

FIGURE 2 Reported average number of hours spent studying per week (mean ± standard error) across the testing sessions.

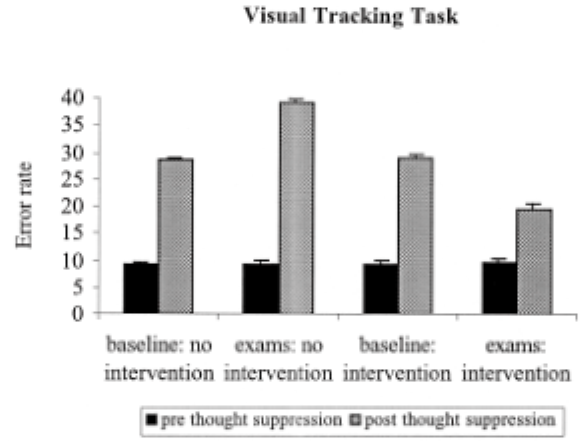

FIGURE 3 Error rate on the visual tracking task (mean ± standard error) measured before and after the thought suppression task across sessions.

across the no-intervention phase. Both cohorts participated in the intervention phase (study program) and we included them in the analyses. The reported average number of hours spent studying were entered into a session (baseline, exams) repeated measures ANOVA. The ANOVA found a significant main effect for session, $F(1, 44) = 24.58$, $p < .001$. These results suggest that although on average, participants' spent 11 hr per week studying, study time increased to an average of 22 hr per week during the intervention phase (study program).

Study diaries. All study diaries were returned to us as instructed. An inspection of the diaries indicated that all participants recorded progress on the study program as instructed. Accordingly, the diary content suggested a roughly equal expenditure of effort from all participants.

Entries from the study diaries indicate that the study program required ongoing regulatory effort. For example, some participant comments include the following: "My studying is improving but it is a constant struggle … especially when everyone is watching TV … I want to join them so bad"; "In order to stick to the program I have to get out of bed an hour earlier so I can get the study hours in … some mornings it is so hard to get up … I'd much prefer to lie in"; and "Studying at uni isn't so bad as everyone is pretty much doing the same thing … but when I get home and my flatmates are heading out to the pub … it is so hard not to go with them … so far I've managed to stay strong and stick to the planned studying." The comments suggest that the academic study program required self-control.

Study Intervention Phase

VTT. Figure 3 summarizes (striped bars) performance on the VTT across the intervention phase (study program). Both cohorts participated in the intervention phase and were included in the analyses. The thought suppression task caused deterioration in performance at baseline (depletion). This effect of depletion, however, appeared to attenuate across sessions, with less depletion during the examination period following participation in the study program. These impressions were confirmed by a Session (Baseline, Exams) × Time (before thought suppression vs. after thought suppression) repeated measures ANOVA. With the ANOVA, we found significant main effects for time, $F(1, 44) = 2395.40$, $p < .001$, indicating a general tendency toward depletion following a previous self-regulatory act; a significant main effect for session, $F(1, 44) = 79.96$, $p < .001$, suggesting that visual tracking performance improved across sessions; and a significant Time × Session interaction, $F(1, 44) = 359.98$, $p < .001$. The pattern of results indicates that the study program improved regulatory stamina, increasing resistance to the debilitating effects of a manipulation of regulatory depletion (a thought suppression task).

Behavioral self-reports. Figures 4 through 10 (black and striped bars) show the reported changes in regulatory behaviors across the intervention phase (study program). Both cohorts participated in the intervention phase and were included in the analyses. We entered the data in Figures 4 through 10 into a repeated measures ANOVA, with Session (Baseline, Exams) as the within-subjects variable. We restricted analyses of each behavior to those individuals who engaged in these activities rather than the entire sample. Table 2 summarizes the main effects of session.

As predicted, people seemed better able to control their behavior during the exam period following the intervention phase (study program). In fact, all of the behaviors showed changes in the predicted direction. Figure 4 shows a reported decrease in chemical consumption during examinations for those people in the study program. Smoking decreased by a mean of 7 cigarettes per day, caffeine consumption decreased on average by 2 cups per week, and alcohol decreased on average by 2 drinks per week. Figure 5 shows changes in dietary trends across sessions. Dietary patterns improved for those participants in the study program, with decreased junk

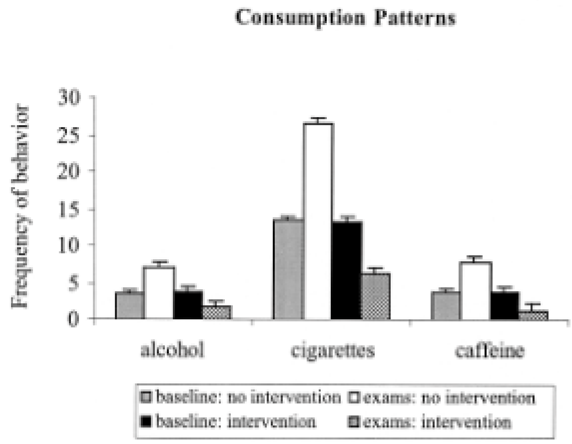

FIGURE 4 Number of cigarettes (over 24 hr), cups of caffeine, and standard units of alcohol (over 7 days) across sessions (mean ± standard error). We restricted analyses of each behavior to those individuals who engaged in these activities rather than the entire sample.

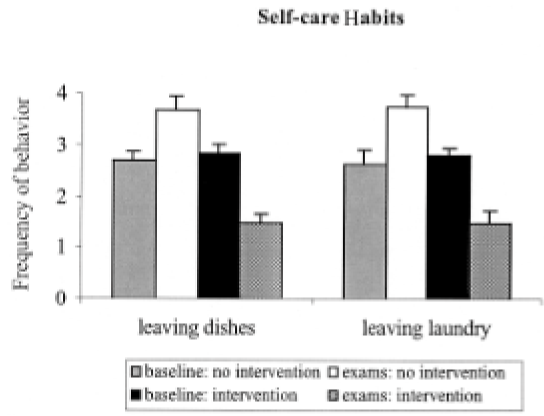

FIGURE 7 Self-care habits across sessions (mean ± standard error). Frequency of behaviors were coded as follows: 0 = never; 1 = once per week; 2 = 2 to 3 times per week; 3 = daily; 4 = more than once per day.

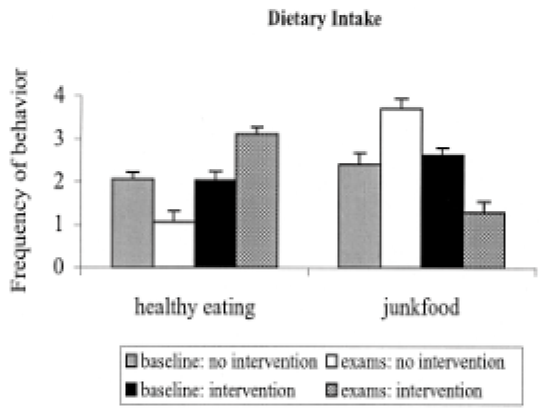

FIGURE 5 Dietary intake across sessions (mean ± standard error). Frequency of behaviors were coded as follows: 0 = never; 1 = once per week; 2 = 2 to 3 times per week; 3 = daily; 4 = more than once per day.

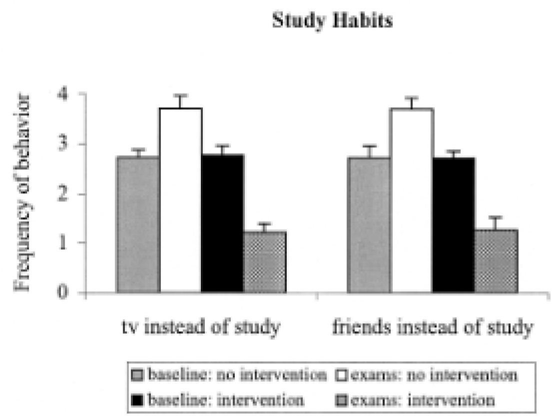

FIGURE 8 Study habits across sessions (mean ± standard error). Frequency of behaviors were coded as follows: 0 = never; 1 = once per week; 2 = 2 to 3 times per week; 3 = daily; 4 = more than once per day.

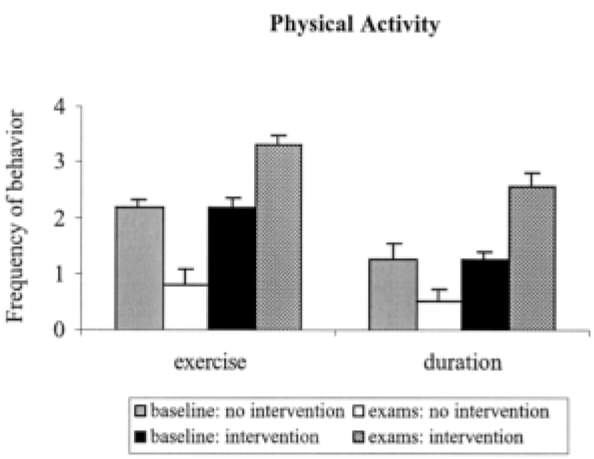

FIGURE 6 Frequency and duration of physical activity across sessions (mean ± standard error). Frequency of behaviors were coded as follows: 0 = never; 1 = once per week; 2 = 2 to 3 times per week; 3 = daily; 4 = more than once per day.

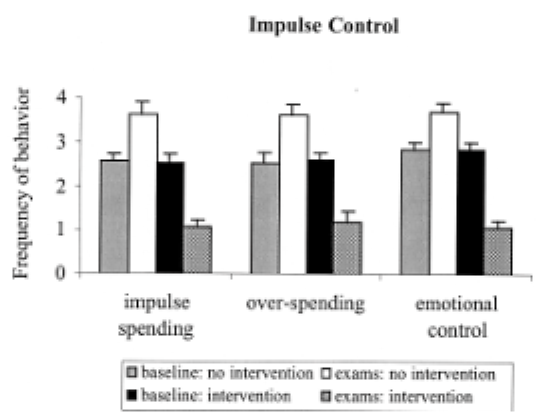

FIGURE 9 Impulse control across sessions (mean ± standard error). Frequency of behaviors were coded as follows: 0 = never; 1 = once per week; 2 = 2 to 3 times per week; 3 = daily; 4 = more than once per day.

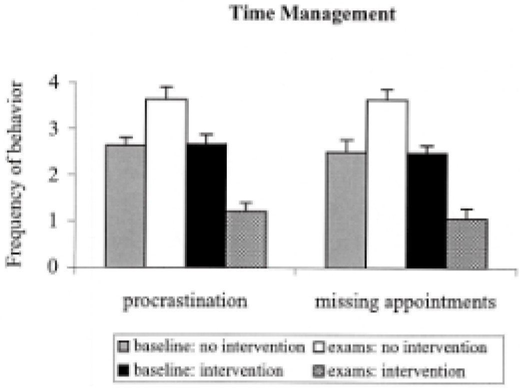

FIGURE 10 Time management across sessions (mean ± standard error). Frequency of behaviors were coded as follows: 0 = never; 1 = once per week; 2 = 2 to 3 times per week; 3 = daily; 4 = more than once per day.

food consumption and an increase in healthy eating habits during the examination period. Figure 6 shows the same pattern for physical activity. During the exam period, the frequency and duration of physical activity increased for those participants in the study program.

Figures 7 through 10 show improvements in general regulatory habits in the lead up to examinations. Following intervention, participants reported an increase in attendance to household chores (leaving the dishes in the sink less often and doing the laundry more often), emotional control, and a decrease in impulse spending, overspending, watching television instead of studying, spending time with friends instead of studying, failures to attend to commitments, and procrastination.

TABLE 2
Regulatory Behavior: Intervention Phase (Study Program)

Behavior	*df*	*F*	*p*
Consumption			
Cigarettes[a]	1, 10	135.87	< .001
Alcohol[b]	1, 24	28.47	< .001
Caffeine[c]	1, 20	43.33	< .001
Physical activity			
Frequency[d]	1, 38	67.86	< .001
Duration[e]		68.14	< .001
Diet[f]			
Junk food	1, 44	103.53	< .001
Healthy habits		78.22	< .001
Self-care habits[f]			
Leaving dishes in sink	1, 44	29.75	< .001
Leaving laundry		29.33	< .001
General regulatory[f]			
TV instead of study	1, 44	47.43	< .001
Friends instead of study		47.42	< .001
Impulse spending		45.34	< .001
Overspending		70.82	< .001
Emotional control		57.00	< .001
Procrastination		43.90	< .001
Missing appointments		47.42	< .001

Note. Analyses restricted to participants who engaged in these behaviors.
[a]$n = 11$. [b]$n = 25$. [c]$n = 21$. [d]$n = 39$. [e]$n = 39$. [f]$N = 45$.

No-Intervention Phase (Waiting-List Control)

VTT. Figure 3 (black bars) summarizes performance on the VTT across the no-intervention phase (waiting-list control). Cohort 2 was the only cohort to participate in the no-intervention phase and was therefore the only cohort included in the following analyses. The thought suppression task caused deterioration in performance at baseline (depletion). This effect of depletion, however, appeared to worsen at exam time for those not participating in the study program. These impressions were confirmed by a Session (Baseline, Exams) × Time (before thought suppression vs. after thought suppression) repeated measures ANOVA. With the ANOVA, we found significant main effects for time, $F(1, 16) = 3136.52$, $p < .001$ and session, $F(1, 16) = 155.82$, $p < .001$, this time suggesting that visual tracking performance worsened across sessions and importantly, a significant Time × Session interaction, $F(1, 16) = 252.12$, $p < .001$. The pattern of results indicates that participants not in the study program were more vulnerable to the debilitating effects of a manipulation of regulatory depletion (a thought suppression task) during the examination period.

We also compared the no-intervention phase (waiting-list control) with the intervention phase (study program) across cohorts. The two cohorts were compared at the same time of year; they were randomly assigned to conditions (see Table 1). We conducted a mixed analysis with session and time serving as within-subjects variables and cohort as the between-subject variable. In the ANOVA, we compared Cohorts 1 and 2, with Session (Baseline, Exams) × Time (before thought suppression vs. after thought suppression) × Cohort (Cohort 1 [intervention phase] vs. Cohort 2 [no-intervention phase]) as factors. The ANOVA found a significant main effect for time, $F(1, 43) = 5016.22$, $p < .001$. There was also a significant Time × Cohort interaction, $F(1, 43) = 295.56$, $p < .001$, indicating that the rates of depletion differed across the cohorts; a significant Session × Cohort interaction, $F(1, 43) = 110.30$, $p < .001$, indicating that overall visual tracking performance differed across groups; and a significant Session × Time × Cohort interaction, $F(1, 43) = 406.64$, $p < .001$. These findings suggest that during the examination period, participants in the intervention phase (study program) showed a pattern of performance consistent with improved stamina, whereas participants not in the study program appeared more susceptible to the depleting effects of a prior regulatory exertion (a thought suppression task).

Behavioral self-reports. Figures 4 through 10 (grey and white bars) show the reported changes in regulatory behaviors across the no-intervention phase (waiting-list control). Cohort 2 was the only cohort to participate in the no-intervention phase and was therefore the only cohort included in the following analyses. We entered the data in Figures 4 through 10 into a repeated measures ANOVA, with session as the within-subjects factor. Table 3 summarizes the main effects of session.

As predicted, people not in the study program (no-intervention phase) appeared less able to control their regulatory behavior during the examination period. In fact, all of the reported behaviors show changes in the predicted direction. Figure 4 shows a reported increase in cigarette smoking, caffeine, and alcohol consumption during the examination period for those people not participating in the study program. Cigarettes increased at a mean rate of 13 cigarettes per day, caffeine consumption increased at a mean rate of 4 cups per week, and alcohol increased at a mean rate of 4 drinks per week.

Figure 5 shows changes in dietary trends across the no-intervention phase, with a reported increase in junk food intake, and a decrease in healthy eating habits. Figure 6 shows a similar pattern for physical activity, with the reported frequency and duration of physical activity of participants not in the study program decreasing during the examinations.

Figures 7 through 10 show deficits in general regulatory habits for those not in the study program in the lead up to examinations. Participants reported a decrease in household chores (laundry, leaving the dishes in the sink) and emotional control and an increase in spending without thinking, overspending, spending time with friends instead of studying, watching television instead of study, failures to attend to commitments, and procrastination.

As with the VTT, we conducted mixed ANOVAs to compare the no-intervention phase (waiting-list control) with the intervention phase (study program) within a single statistical test. Again, the two cohorts were randomly assigned and compared at the same points in the semester (see Table 1). We entered each dependant variable in Figures 4 through 10 into the following analyses: a Session (Baseline, Exams) × Cohort (Cohort 1 [intervention phase] vs. Cohort 2 [no-intervention phase]) repeated measures ANOVA. Table 4 summarizes the inferential statistics. Consistent with the within-subjects analyses, significant Cohort × Session interactions indicate that during the examination period, self-regulation in all variables improved for those participants in the inter-

TABLE 3
Regulatory Behavior: No-Intervention Phase (Waiting-List Control)

Behavior	*df*	*F*	*p*
Consumption			
Cigarettes[a]	1, 5	106.50	< .001
Alcohol[b]	1, 10	19.55	< .001
Caffeine[c]	1, 8	23.10	< .001
Physical activity[d]			
Frequency	1, 16	35.86	< .001
Duration		12.78	< .001
Diet[d]			
Junk food	1, 16	47.80	< .001
Healthy habits		27.20	< .001
Self-care habits[d]			
Leaving dishes in sink	1, 16	13.19	< .001
Leaving laundry		13.18	< .001
General regulatory behavior[d]			
TV instead of study		19.43	< .001
Friends instead of study		19.42	< .001
Impulse spending		16.10	< .001
Overspending		12.24	< .001
Emotional control		34.00	< .001
Procrastination		19.43	< .001
Missing appointments		15.61	< .001

Note. Analyses restricted to participants who engaged in these behaviors.
[a]n= 6. [b]n = 11. [c]n = 9. [d]N = 17.

TABLE 4
Regulatory Behavior: Cohort 1 (Intervention Phase) Versus Cohort 2 (No-Intervention Phase)

Behavior	*df*	*F*	*p*
Consumption			
Cigarettes[a]	1, 9	16.03	< .001
× Cohort		145.24	< .001
Alcohol[b]	1, 23	5.95	< .001
× Cohort		37.97	< .001
Caffeine[c]	1, 19	4.23	< .001
× Cohort		45.58	< .001
Physical activity			
Frequency[d]	1, 37	6.46	< .001
× Cohort		60.28	< .001
Duration[d]		12.04	< .001
× Cohort		44.32	< .001
Diet[e]			
Junk food	1, 43	7.22	< .001
× Cohort		131.65	< .001
Healthy habits		9.43	< .001
× Cohort		131.64	< .001
Self-care habits[e]			
Leaving dishes in sink	1, 43	6.29	< .001
× Cohort		31.01	< .001
Doing laundry		6.32	< .001
× Cohort			< .001
General regulatory behavior[e]			
TV instead of study	1, 43	5.12	.010
× Cohort		41.55	< .001
Friends instead of study		11.12	< .001
× Cohort		41.55	< .001
Impulse spending		11.47	< .001
× Cohort		47.18	< .001
Overspending		12.82	< .001
× Cohort		41.75	< .001
Emotional control		4.67	.030
× Cohort		46.52	< .001
Procrastination		15.25	< .001
× Cohort		15.25	< .001
Missing appointments		12.97	< .001
× Cohort		15.29	< .001

Note. Analyses restricted to participants who engaged in these behaviors.
[a]n = 11. [b]n = 25. [c]n = 21. [d]n = 39. [e]N = 45.

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TABLE 5
Regulatory Behavior: Control Phase Mean and Standard Error

Behavior	Baseline *M*	Baseline *SE*	Follow-Up *M*	Follow-Up *SE*	*R*
Emotional responses[a]					
Perceived stress scale	19.1	0.5	19.2	0.8	.98*
General health questionnaire	18.8	0.4	18.6	0.3	.94*
General self-efficacy scale	19.3	0.7	19.3	0.8	.96*
Consumption[b]					
Cigarettes[b]	3.1	1.0	3.0	1.0	.96*
Alcohol[c]	2.1	0.6	2.1	0.6	.94*
Caffeine[d]	6.0	0.5	6.2	0.5	.91*
Physical activity[a]					
Frequency	2.1	0.3	2.3	0.2	.97*
Duration	1.2	0.3	1.2	0.2	.97*
Diet[a]					
Junk food	14.2	0.2	14.2	0.2	.97*
Healthy habits	3.2	0.3	3.2	0.2	.97*
Self-care habits[a]					
Leaving dishes in sink	2.9	0.3	2.9	0.3	.92*
Leaving laundry	2.8	0.3	2.7	0.2	.93*
General regulatory[a]					
TV instead of study	2.7	0.3	2.7	0.2	.96*
Friends instead of study	2.6	0.3	2.7	0.2	.96*
Impulse spending	2.4	0.2	2.5	0.3	.90*
Overspending	2.4	0.3	2.5	0.3	.80*
Emotional control	2.9	0.2	2.9	0.2	.97*
Procrastination	2.6	0.3	2.7	0.2	.98*
Missing appointments	2.5	0.3	2.5	0.3	.94*

[a]$N = 17$. [b]$n = 6$. [c]$n = 11$. [d]$n = 9$.
*p is significant at the .01 level, two-tailed.

TABLE 6
Relationship Between VTT and Behavioral Self-Reports

Behavior Difference	*VTT Difference*
Consumption	
Cigarettes[a]	.46*
Alcohol[b]	.44*
Caffeine[c]	.44*
Physical activity	
Frequency[d]	.49*
Duration[d]	.49*
Diet[e]	
Junk food	.55*
Healthy habits	.45*
Self-care habits difference[e]	
Leaving dishes in sink	.47*
Doing laundry	.48*
Regulatory[e]	
TV instead of study	.48*
Friends instead of study	.58*
Impulse spending	.49*
Overspending	.49*
Emotional control	.56*
Procrastination	.58*
Missing appointments	.52*

Note. Analyses restricted to those participants who engaged in these behaviors. VTT = visual tracking task.
[a]$n = 11$. [b]$n = 25$. [c]$n = 21$. [d]$n = 39$. [e]$N = 45$.
*p is significant at the .01 level, two-tailed.

vention phase (study program), whereas regulatory behavior worsened for those participants not in the study program (no-intervention phase).

Control Phase

Cohort 2 was the only cohort to participate in the control phase (testing during nonstressful times) and was therefore the only cohort included in the following analyses. Table 5 reports the regulatory behavior (mean ± standard error) during the control phase. There were no significant effects for any of the regulatory behaviors (laboratory or self-reported) across the control sessions, indicating that regulatory behavior remained stable during the control phase (Table 5).

Test–retest reliability of the general regulatory questionnaire was calculated using the Pearson correlation coefficient by correlating Session 1 (baseline) scores with Session 2 (follow-up) scores from the control phase. Retest reliabilities (Table 5) were generally high, with all but one at .90 or better.

Relation Between VTT and Behavioral Self-Reports

We tested whether the degree of change in VTT performance across the intervention phase (study program) predicted: (a) the reported regulatory behaviors at baseline, (b) the reported regulatory behaviors during exams, and (c) the degree of change in reported regulatory behavior across the intervention phase (study program). Both cohorts participated in the exercise phase and we included both in the analyses. We measured the degree of change using differences across sessions: intervention Session 2 (exams) score minus intervention Session 1 (baseline) score. We correlated the difference scores of VTT performance (Pearson) with the differences scores of general regulatory behavior (Table 6). There were no significant correlations between the degree of change in VTT performance and regulatory behavior reported at baseline or during the exams.

The correlations between degree of change in VTT performance and the degree of change in reported regulatory behavior across the intervention phase (study program), however, were all significant, suggesting that changes in the VTT and in the regulatory behavior questionnaire are measuring something in common, which we believe to be changes in self-control.

We also tested whether the predepletion VTT performance predicted the degree of change in regulatory behavior across the intervention phase (study program). There were no significant correlations. This suggests that the observed positive changes in regulatory behavior are not related to task performance. Thus, VTT performance before any manipulations did not predict the improvements in behavior.

TABLE 7
Emotional Response Means and Standard Errors

Measure	Baseline: No Intervention *M*	Baseline: No Intervention *SE*	Exams: No Intervention *M*	Exams: No Intervention *SE*	Baseline: Intervention *M*	Baseline: Intervention *SE*	Exams: Intervention *M*	Exams: Intervention *SE*
Perceived Stress Scale	19.47	0.6	29.41	0.5	19.12	0.5	19.29	0.8
Emotional Distress (GHQ)	18.76	0.4	30.82	0.3	18.88	0.5	18.65	0.3
Self-Efficacy (GSES)	19.41	0.6	19.53	1.0	19.49	0.5	19.27	0.4

Note. GHQ = General Health Questionnaire; GSES = General Self-Efficacy Scale.

Psychosocial Self-Reports

Table 7 shows the reported changes in self-efficacy, perceived stress, and emotional distress across the no-intervention phase (waiting-list control) and the intervention phase (study program). Cohort 2 was the only cohort to participate in both phases (no-intervention and intervention) and was therefore the only cohort we include in the following analyses.

Self-efficacy. Reports of self-efficacy remained stable across sessions. The repeated-measures analysis for the GSES showed no effect of session across the intervention, waiting-list control, or control phases.

Perceived stress. Inspection of Table 7 suggests that perceived stress increased in anticipation of examinations for those participants in the waiting-list control (no-intervention phase). The repeated measures analysis of the PSS showed a significant effect of session, $F(1, 16) = 349.370$, $p < .001$, indicating that perceived stress increased in anticipation of examinations for those not in the study program. Reports of perceived stress, however, remained stable across sessions for those in the study program (intervention phase). The repeated measures analysis for the PSS showed no effect of session across the intervention phase.

Emotional distress. The emotional distress data in Table 7 show a similar pattern to PSS ratings. The repeated measures analysis of the GHQ also showed a significant effect of session, $F(1, 16) = 694.63$, $p < .001$, indicating that emotional distress also increased for those participants not in the study program during the lead up to examination. Reports of emotional distress also remained stable across sessions for those in the study program. The repeated measures analysis for the GHQ showed no effect of session across the intervention phase.

We also entered VTT performance (see data in Figure 3) and self-reported regulatory behavior (see data in Figures 4–10) into a Session (Baseline, Exams) × Time (before thought suppression vs. after thought suppression) repeated measures analyses of covariance, with self-efficacy, perceived stress, and emotional distress as covariates. The effects of these covariates (self-efficacy, perceived stress, or emotional distress) were not significant. This suggests that the positive improvements observed in regulatory behavior are due to the effects of the study program.

DISCUSSION

The results are consistent with the predictions of a limited strength model of self-control. We found that students who were dealing with academic examination stress reported breakdowns in regulatory behavior that were not matched during the control phase, replicating our previous findings (Oaten & Cheng, 2005a). The main new finding to emerge was that students who participated in a study program over a 2-month period reported no increased stress at exam time and significant improvements in a wide range of regulatory behaviors. We found improvements in both a laboratory task (VTT) and on all self-reported regulatory behaviors. The participants not only studied more and improved study habits but also improved their behavior in many ways outside the context of academic habits. We observed a decrease in tobacco, alcohol, and caffeine consumption and an increase in healthy dietary habits, emotional control, maintenance of household chores and self-care habits, attendance to commitments, and monitoring of spending. The laboratory measure and the self-reported behaviors bore no direct resemblance to the study program other than that they all involved self-regulation. Participation in the study program improved performance on all the behaviors of interest.

As already mentioned, the VTT has been administered following both regulatory and nonregulatory tasks (Oaten et al., 2005; Oaten & Cheng, 2005b), and performance on this task is sensitive to depletion manipulations but not to nondepleting tasks. On this laboratory task, we found evidence of depletion as indicated by a deterioration in performance following the thought suppression task in all experimental sessions. This effect of depletion, however, was attenuated significantly after the study program was introduced. The study program helped to reduce but not eliminate the effects of depletion. Although the etiology of the self-reported improvements is unclear, the laboratory data suggest that the adoption of the study program made students less susceptible to the debilitating effects of regulatory depletion, an improvement in stamina.

We see the improvement in regulatory behaviors at exam time for the intervention condition as having two causes derived from the program of regular studying. One is that the study program effectively wiped out exam stress as indicated by similar scores on the PSS and the GHQ during exam time and during mid-semester. Prevention of stress escalation by itself, however, should have only brought self-regulation back to baseline at a comparable level to mid-semester. This results from eliminating the need to expend regulatory resources to deal with stress. To explain improved self-regulation, however, requires another ingredient. In addition, we argue that the study program improved regulatory stamina. This, coupled with a lack of increase in stress, led to improved self-regulation.

These findings converge with those of Muraven et al. (1999), Oaten et al. (2003) and Oaten and Cheng (2005b) to show that the repeated practice of self-control can improve the strength or capacity for self-regulation. All our procedures and measures were different from what the Muraven et al. (1999), Oaten et al. (2003), and Oaten and Cheng (2005b) studies used, which therefore increases confidence in the generality of the pattern. The initial studies of Muraven et al. (1999) and Oaten et al. (2003) provide preliminary evidence that regulatory strength may be improved, but the findings are limited. The regulatory exercises in these studies were artificial and short (2 weeks) in total duration. Oaten and Cheng (2005b) improved on this design by measuring more than just a single laboratory task and by having participants literally exercising, that is, begin and maintain a program of cardiovascular exercise. This is a form of self-regulatory exercise that many aspire to do in everyday life. It is worth noting that a similar pattern of results was found: an improvement in both the laboratory VTT and on self-reported, day-to-day regulatory behaviors. In the VTT, it was again stamina that improved.

Students on the program waiting list, however, did not fare so well during the examination period. They reported an increase in smoking, caffeine consumption, and alcohol consumption; a decrease in healthy dietary habits, emotional control, frequency and duration of physical activity, maintenance of household chores, attendance to commitments, and monitoring of spending; as well as deterioration of study habits. As we noted previously, we found evidence of depletion as indicated by impaired visual tracking performance following the thought suppression task in all testing sessions. This effect of depletion, however, increased significantly at a stressful time. During the exam period, performance on the predepletion VTT was equivalent to baseline performance. The postdepletion VTT performance, however, worsened more than it did at a less stressful time, showing that these students became more depleted after engaging in equivalent regulatory effort as during a less stressful time. This greater effect of depletion supports the claim that students on the program waiting list had less regulatory stamina during the exam period.

The design of this study ensured that the manipulations and measures were as dissimilar as possible. There was no obvious reason why the study program should alter the effect of trying to suppress thoughts of a white bear on VTT performance. Nor was there any apparent explanation why the study program might benefit, for example, attendance to commitments. The link between all of these behaviors was that they all required self-regulation. It was important to demonstrate depletion and improvement in circumstances as diverse as possible to rule out the possibility that the results are artifacts of a particular method.

Appropriate controls show that the study program was necessary for the improvement. People on the waiting list for the study program reported an increase in regulatory failures during the examination period. Such regulatory impairment, however, was reversed following the adoption of the study program. Therefore, the students had to actually adhere to the study program for a period of time before any improvements were observed. It did not matter what semester the program was administered in; what was important was that the students actually undertook the program. The fact that regulatory behavior was stable during the control phase also indicates that any observed improvement was not an outcome of multiple testing sessions or practice at the laboratory task but instead was produced by the adoption of the study program. Furthermore, improvements in both self-reported behaviors and objective behavioral measures obtained in the laboratory give converging evidence.

Longitudinal studies lose some of the control that nonlongitudinal studies offer. Several aspects of this research, however, increase confidence in the findings. First, this research was able to sustain a 100% rate of participation in contrast to the high dropout rate found in many longitudinal designs. This is in part owing to the relatively short duration of the study and to the distribution of study diaries that helped to keep students focused on the study program. The experimental design also required that participants report regularly to us (experimental sessions, study register, study diary, false deadlines, and study schedule). Such interpersonal monitoring gave a good manipulation check and might have also influenced participant retention. Second, participants in the no-intervention condition were willing to report significant degradations in behavior. This gives some confidence that participants in the intervention condition were not merely presenting a good image of themselves. Third, the reported behaviors all had high reliability (Table 5). Fourth, improvements in the self-reported behaviors correlated with the improvement on the laboratory task (Table 6). This suggests that the reported improvements in behavior shared something in common with improvements in an objective laboratory task, something that we interpret to be improvement in self-control. In this way, both types of measures gain some validity, although further psychometric testing is required before firm inferences can be drawn regarding validity.

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Alternative Explanations

The reported breakdowns in self-control at exam time in the no-intervention condition could be considered a function of stress. For example, managing stress might cause an increase in the desire to smoke, eat, or drink. In fact, this is consistent with these findings. Students on the program waiting list showed an impaired ability to regulate these very behaviors at reported periods of perceived high stress (exam time). These same students, however, also showed an impaired ability to control behaviors that do not necessarily serve a stress-relieving function (emotional control, maintenance of household chores, attendance to commitments, monitoring of spending and study habits) during the exam period. This suggests that the negative regulatory effects observed at exam time were not solely in the service of stress reduction.

We have argued that attempts to regulate stress during the exam period decreased self-control stamina for students on the program waiting list. Another possible explanation for the observed regulatory failures involves time management strategies. It may be that the breakdowns in regulatory behavior for those students in the program waiting list reflect a time-saving tactic adopted to accommodate the higher order goal of study in the period preceding examinations. Physical activity, the preparation of healthy meals, and household chores seem like obvious sacrifices during periods of high academic demand. Students, however, reported increases in unchecked spending, loss of emotional control, procrastination, nonattendance to planned schedules, and spending time with friends and watching television instead of studying. These behaviors are costly to the individual and seem counterproductive in the lead up to examinations. Moreover, students participating in the study program were not only able to manage all regulatory behaviors, but we also saw increases in the frequency of regulatory behavior, this in conjunction with increased hours of studying. It seems unlikely, then, that the reported changes in regulatory behavior are produced solely by time-management strategies.

Perhaps demand characteristics and socially desirable responding produced the reported improvements in general regulatory behavior. Conway and Ross (1984) randomly selected students for a study skills program and a waiting list for the program. At the initial interview, participants and controls did not differ significantly on any measure of skill or time spent studying. Both groups performed equally well and the program itself was not found to improve study skills. The program participants, however, reported an improvement in a direction consistent with their beliefs regarding program outcomes (improved study skills). It is possible that participants in this study also exaggerated their reported improvements to fit with expected program outcomes. We are inclined to believe, however, that exaggeration and self-report bias cannot explain all the reported improvements. First, the improvement obtained in the laboratory task (VTT) cannot be explained by such self-report bias. Second, as we already mentioned, the extent of improvement on the laboratory task predicted the extent of improvement on all self-report measures (Table 6), lending some validity to the self-report measures.

Past research has found links between success in academic programs of study and improved self-efficacy (Archer & Lamnin, 1985; Britton & Tesser, 1991). We, however, found that students who engaged in the study program did not differ in perceived self-efficacy from participants in the waiting-list control (Table 5). In fact, self-efficacy was stable across all phases. This suggests that the “active ingredient” in the observed regulatory improvement is something specific to the ongoing participation in the program and cannot be explained by a heightened sense of self-efficacy.

Improved mood may have generated the positive results. Participants reported an increase in regular physical activity during the intervention phase. Regular physical activity has been linked to improved mood (Lawlor & Hopker, 2001). Being well prepared in studies might also improve mood. The pattern of performance on the laboratory task, however, suggests an improvement specifically related to self-regulation following depletion. If, for example, improved mood were producing these effects, why would we only observe any improvement in task performance following thought suppression? It seems doubtful then that the reported changes in regulatory behaviors would be produced solely by improved mood. Nevertheless, it will take a number of studies to fully unconfound the effects of various possible factors. Considering together all studies on the exercise of self-control (Muraven et al., 1999; Oaten & Cheng, 2005a; Oaten & Cheng, 2005b; Oaten et al., 2003), the converging evidence points to the repeated practice of self-control as the key ingredient in improving self-control. We therefore consider the resource model as offering the best fit for these findings.

Implications

The results suggest that when life events impose extra demands on self-regulatory resources (such as during final examinations), self-regulation may begin to fail in other spheres (e.g., dieting) where control has normally been successful. Stress management strategies, however, should benefit people to the extent that by coping with life pressures effectively, people may store their regulatory strength for actions of self-change that truly demand the effort (Baumeister & Exline, 2000).

Even better news is that people may do more than just manage stress. Our results show that individuals who studied regularly and systematically enjoyed an increased resistance to the debilitating effects of the examination period reported no increase in stress. Stress prevention may work even better than stress management. The regular practice of self-control needed to prevent stress has the added benefit of improving self-regulatory stamina (see also Oaten & Cheng, 2005b). In fact, the strength model posits that individuals should improve in self-control ability even after failing a self-regulatory task because the exertion of self-control is more important than the outcome (Muraven & Baumeister, 2000). Therefore, setting oneself small but frequent challenges for self-improvement may be useful for building up a good capacity for self-discipline.

Our findings are both theoretically and practically important. Theoretically, we demonstrated in the study that the resource of self-control is not fixed and may be augmented by suitable behaviors. Although the range of routes to improvement remains unclear, the data we report clearly demonstrate one route that has wide-ranging consequences. Our study on the effects of regular physical exercise (Oaten & Cheng, 2005b) demonstrated another route with broad benefits for self-control. Therefore, practicing self-regulation in any domain may have beneficial long-term consequences. The practical importance of building self-control strength can be more fully appreciated when considering that many societal problems involve breakdowns in self-regulation. For example, addiction is marked by the inability to control cravings for alcohol or drugs. Additionally, many people may incur financial debt as a result of the inability to limit consumer spending. By improving regulatory strength, people may in turn diminish their vulnerability to such breakdowns and live longer and healthier lives.

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