

Conserving Self-Control Strength

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Individuals may be motivated to limit their use of self-control resources, especially when they have depleted some of that resource. Expecting to need self-control strength in the future should heighten the motivation to conserve strength. In 4 experiments, it was found that depleted participants who anticipated exerting self-control in the future performed more poorly in an intervening test of self-control than participants who were not depleted, and more poorly than those who did not expect to exert self-control in the future. Conversely, those who conserved strength performed better on tasks that they conserved the strength for as compared with those who did not conserve. The underlying economic or conservation of resource model sheds some light on the operation of self-control strength.

Keywords: self-control strength, self-regulation, motivation, goals, conservation

One of the primary strengths of humans is that they can consider the future. The consequences, outcomes, or implications of an action often shape our present behavior. The desire to be healthy in the future may lead one to quit smoking or persist on a diet. In that way, the future can affect the present, as individuals change their behavior to foster the occurrence of a desired outcome in the future. Indeed, the whole process of self-regulation entails guiding current behavior to reach a future goal (Carver & Scheier, 1998; Higgins, 1996).

Self-regulation comes at a cost, however. Besides entailing the forgoing of pleasures (Tice, Bratslavsky, & Baumeister, 2001), the exertion of self-control appears to deplete a limited resource (self-control strength) needed for the success of self-control (Muraven & Baumeister, 2000). This strength is recovered slowly, so that immediately after exerting self-control, there is less of this vital resource. Because of the crucial but limited nature of self-control strength, people must be judicious in their management of it (as with other limited resources; see Hobfoll, 2002). If a person spends too much of this resource on a low-priority project (e.g., being nice to fellow drivers during rush hour), he or she might not have enough strength for critical, high-priority projects (e.g., not bingeing on alcohol).

For that reason, understanding how people allot limited resources may be important for understanding self-control. Given the limited nature of self-control, individuals are making decisions (likely unconsciously) about how to apportion a limited resource whenever they exert self-control. This is important because the allocation of self-control resources might help explain why after one exerts self-control, subsequent self-control performance suffers (e.g., Baumeister, Bratslavsky, Muraven, & Tice, 1998; Muraven, Collins, & Nienhaus, 2002; Muraven, Tice, & Baumeister, 1998; Vohs & Heatherton, 2000). In particular, we argue that the desire to conserve resources for future demands may help explain why self-control suffers. Individuals who recently exerted self-control may have a greater desire to conserve energy than individuals who did not exert self-control, which may help explain why exerting self-control leads to poorer performance just afterward.

The Nature of Self-Control

We define *self-control* as the overriding or inhibiting of automatic, habitual, or innate behaviors, urges, emotions, or desires that would otherwise interfere with goal directed behavior (Barkley, 1997a; Baumeister, Heatherton, & Tice, 1994; Kanfer & Karoly, 1972). When people exert self-control, they inhibit their normal, typical, or automatic behavior (Bargh & Chartrand, 1999). For example, if someone typically smokes after eating, then it requires the exertion of self-control to alter this habit and not smoke after dinner. If the person does not exert self-control, he or she will behave automatically and smoke (Tiffany, 1990). People exert self-control because they want to follow a rule (either externally or internally determined) or delay gratification (Barkley, 1997a; Hayes, 1989; Shallice & Burgess, 1993). Overcoming a habitual or instinctual pattern of acting by definition requires self-control.

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Recent research supports the argument that individuals treat self-control as a limited resource that gets depleted with use. In particular, if self-control is a limited resource, then performance on subsequent self-control tasks should be diminished after the exertion of self-control (e.g., Baumeister et al., 1998; Muraven et al., 1998; Vohs & Heatherton, 2000; Wallace & Baumeister, 2002). When placed in a situation that required drinking restraint (participants believed they would be taking a driving test after sampling some beer), participants who had to override their thoughts (a task that requires self-control) prior to drinking consumed more alcohol and were more intoxicated than participants who solved simple arithmetic problems prior to drinking (Muraven et al., 2002). Notably, only the amount of self-control exerted in the first phase of the experiment was related to the subsequent inability to regulate alcohol intake; participants did not drink more after regulating their thoughts because they were more frustrated, irritated, aroused, or otherwise unhappy. Consistent with prior research, exerting self-control (and only self-control; see Baumeister et al., 1998; Muraven & Slessareva, 2003) leads to a decline in self-control performance subsequently.

Research has found a correlation between the amount of self-control exerted and subsequent self-control performance (e.g., Muraven et al., 2002). However, additional research suggests that the relationship between self-control resources and self-control performance is perhaps more complicated. Most notably, the motivation to exert self-control and the rewards people receive for exerting self-control moderate the relationship between depletion and self-control performance (Muraven & Slessareva, 2003). This is significant because a complete theory of self-control strength will have to explain why the exertion of self-control often (but not always) leads to poorer self-control performance subsequently.

The moderation of depletion by motivation suggests that self-control suffers in many situations because individuals are not unable but instead are not willing to exert sufficient self-control to overcome the impulse. There are several reasons why people may be less willing to exert sufficient self-control: It requires much effort, it is unpleasant, or it is too costly. The current research addresses the last point: People may fail at self-control because they are more concerned with conserving strength than with the outcomes of self-control. This may help explain why exerting self-control has been shown to lead to a decline in self-control performance and further develop the ideas underlying the self-control strength model.

Conservation of Resources

The desire to conserve strength and the associated aversion to losing strength may explain why anticipating a self-control demand leads to poorer self-control on an unrelated task. From an economic perspective (Tversky & Kahneman, 1981), self-control can be viewed as the investment of a limited resource (self-control strength) in an unknown but risky endeavor. This means that the loss of self-control strength is given more weight than a comparable gain (Hobfoll, 2002; Hobfoll, Johnson, Ennis, & Jackson, 2003; Tversky & Kahneman, 1981). Consistent with that economic idea, theories of the management of limited resources have shown that for limited and depletable resources (e.g., energy, social support) that are recovered slowly, people are motivated to obtain, retain, and protect their supply (Hobfoll, 2002). Individuals hold

energy in reserve when the benefits of using the resource do not outweigh the costs of depleting it (Schönplflug, 1983). In short, people may try to minimize the amount of self-control strength they deplete by being selective in their self-control efforts.

Furthermore, this motivation to conserve should be intensified among those who have recently lost resources. Individuals who have already suffered a loss or who have fewer resources value, defend, and are less likely to use their remaining resources more than individuals who have greater resources (Norris & Kaniasty, 1996; Park & Folkman, 1997). Those whose self-control strength has been more depleted should try to avoid expending more strength as compared with others who are less depleted.

Finally, anticipation of future demands on resources may affect people, especially those lower in resources, as they prepare for the potential loss (Folkman & Lazarus, 1985; Gottlieb, 1987). People may prepare for future losses by conserving what resources they have (Aspinwall & Taylor, 1997). This preparation for future losses may be magnified by the degree of the future demand as well as the person's personal resources. Those who are lower in resources should be more motivated to conserve and protect what resources they have as compared with those with greater resources.

Hence, because we posit that self-control strength is a limited resource that is recovered slowly (for more on the recovery of lost self-control strength, see Tice, Baumeister, Shmueli, & Muraven, 2005), depleted persons should be more motivated to conserve strength than less depleted persons. This increased motivation to conserve (at either a conscious or an unconscious level) may be reflected in poorer self-control performance, as the person becomes less willing to invest the required resources to succeed at self-control. As outlined earlier, the motivation to conserve may be heightened when the person expects to exert self-control in the future, especially when the person is already motivated to protect his or her resources. Put another way, anticipating self-control in the future may have a larger effect on depleted individuals as compared with less depleted individuals. Self-control performance may depend on both past and future self-control demands.

We tested the hypotheses generated by this conservation model in four experiments. If the decline in self-control performance after exerting self-control is a result of increased conservation of resources, then depleted participants who expect to exert self-control (and only self-control) in the future should value their strength more, be more concerned with future demands, and try to conserve their strength to a greater degree. Hence, depleted participants should perform more poorly on an intervening test of self-control before this anticipated task. Looking at how future self-control demands affect depleted persons allows us to determine whether conservation of limited resources underlies many of the phenomena associated with self-control strength.

Experiment 1

In Experiment 1, participants' desire to conserve strength was enhanced by having them believe that they would have to engage in self-control in the near future. They were told that after the dependent measure they would take another test of performance. The final test of performance was described as difficult and effortful. Half the participants were led to believe that the task would also require self-control, whereas the other half believed that the task would not require self-control.

The desire to conserve self-control strength should be the strongest when the individual has little strength and expects to need his or her remaining strength in the future. Therefore, participants who are more depleted and who expect to engage in self-control in the future should perform more poorly on a test of self-control than those who are less depleted and do not expect to engage in self-regulation in the future and more poorly than less depleted participants.

Method

Participants

Ninety-four undergraduate students (61 men and 33 women) were recruited for Experiment 1. One male participant who indicated that he had a health problem that precluded putting his hand in ice water was excused; thus, the data for 93 participants are reported here. Participants received partial course credit in return for their participation. Each individual testing session lasted about 30 min.

Procedure

The experimenter told participants that they were taking part in an experiment looking at the role of concentration on performance. Participants were told that they would take several general tests of concentration and distraction. They were not informed of the depletion model, nor were they told that their self-control performance was being investigated. The experimenter was unaware of the research hypotheses. In this experiment (and the ones that follow), the same basic procedures were followed. First, participants' self-control strength was depleted (Task 1). After that, they were told about two additional tests: the one that would serve as the dependent measure (Task 2) and a task on which anticipation of future need for self-control could be manipulated (Task 3). In particular, participants were told that after Task 2, they would engage in a third task that might require some degree of self-control. They then engaged in Task 2 only.

Depletion phase. Participants were then randomly assigned to either solve moderately difficult multiplication problems (math problem condition) or suppress the thought of a white bear (thought suppression condition). Participants in the thought suppression condition were asked to write down their thoughts on a piece of paper while trying to avoid thinking about a white bear (Wegner, Schneider, Carter, & White, 1987). Participants in the math problem condition solved difficult multiplication problems. Previous research (Muraven et al., 1998, 2002) and pretesting has found that participants rate thought suppression as equally frustrating, difficult, unpleasant, effortful, and arousing as working on arithmetic problems. The only difference between the two conditions was the amount of inhibition or self-control required (see Muraven et al., 2002). Suppressing one's thoughts requires overriding or inhibiting in order to succeed at the task, whereas solving math problems is a relatively automatic activity that should require far less inhibition. Therefore, only thought suppression should produce depletion.

After 5 min had passed, the experimenter reentered the room and gave participants a brief manipulation check. Participants were asked about amount of effort they exerted on that task ("How much effort did you exert on the white bears/math problems?" on a 25-point scale ranging from *no effort to all my effort*) and any frustration generated by the task ("How frustrating was that task?" rated on a 25-point scale ranging from *not frustrating to extremely frustrating*).

Anticipation of future task. The next two tests were then explained to participants. First, they were told about Task 2, the cold pressor task (described later in this article). They were then told that the third and final task would be a test of emotional awareness and that they would watch a short video of a stand-up comedian. The video was described to them in detail, and participants were repeatedly told that the comedian was ex-

remely funny. Half the participants were given no further instructions: They were led to believe that after Task 2 they would watch the video and answer a few questions about it (anticipate no self-control condition). The other half of the participants were told that they would have to control their emotions while watching the video (anticipate self-control condition). They should not laugh or smile, no matter how funny they found the video. The experimenter told participants that not laughing at the video is extremely difficult and requires a great deal of self-control. Previous research has indeed found that not laughing requires a great deal of self-control and is depleting (Muraven et al., 1998). Thus, participants in the future self-control condition anticipated a difficult attempt at self-control that might use up some of their self-control resources following Task 2.

At this point, participants completed another brief manipulation check to assess their perception of the future tasks. In particular, they were asked how much effort they expect to exert on the third task ("How much effort did you plan to exert on Task 3?" rated on a 25-point scale ranging from *no effort to all my effort*), and how much energy that task would demand ("How much energy did you expect the last task would require?" rated on a 25-point scale ranging from *very little to very much*).

Measurement phase. Participants then engaged in Task 2. This test of self-control, known as the cold pressor task, required them to hold their nondominant hand motionless in ice cold water for as long as possible. Holding one's hand in cold water is uncomfortable and people typically wish to remove their hand from the water as soon as possible. People must therefore engage in self-control to override their desire to remove their hand from the water. Participants with greater self-control typically keep their hand in the water longer than participants with less self-control (Baker & Kirsch, 1991; Litt, 1988).

The water temperature was maintained using a mixture of ice and water, and a pump was used to keep the water circulating. To ensure an equal starting point, all participants first held their hand in room temperature water for 1 min before they put their hand in the ice water. The ambient room temperature was maintained at 18° C.

Participants were told to place their hand in the ice water and to not move the hand or fingers. They were told to hold their hand in the water as long as they could and that they should only remove their hand when they could not bear the cold any more. Thus, participants were instructed to fight against the urge to remove the hand. The experimenter started timing using a stopwatch the moment their hand was fully submerged (half the forearm underwater) and stopped timing once the entire hand was removed from the water.

After the cold pressor task, participants were told that there would not be enough time for the third task and that the experiment was over. At this point, they completed a final manipulation and procedure check. They were asked whether they were trying to conserve strength for the final task ("How much were you trying to conserve your energy for the third task?" rated on a 25-point scale ranging from *not at all to very much*), how important it was to them to conserve strength ("How important was it to you to conserve strength for the final task?" rated on a 25-point scale ranging from *not at all to very much*). They were also asked about their performance on the cold pressor task ("How much effort did you exert to keep your hand in the water?" rated on a 25-point scale ranging from *no effort to all my effort*). Finally, participants were carefully debriefed about their research experience. No one reported awareness of the conservation hypothesis.

Results

Manipulation Check

As shown in Table 1, participants in the thought suppression condition reported that they exerted the same amount of effort as compared with participants in the math problem condition, $t(90) = 0.80$, *ns*, and were no more frustrated by the first task, $t(90) =$

Table 1
Experiment 1: Responses on Key Variables Based on Initial Task and Expectation for Future Self-Control

Variable	Depleted				Not depleted			
	Anticipate self-control		Anticipate no self-control		Anticipate self-control		Anticipate no self-control	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Effort on initial task	12.58 _a	5.89	12.23 _a	7.45	14.04 _a	6.83	13.09 _a	6.65
Frustration on initial task	8.28 _a	7.49	10.11 _a	7.36	8.86 _a	6.64	9.04 _a	7.27
Anticipated self-control effort on third task	17.72 _a	4.10	11.06 _b	5.63	17.80 _a	4.74	12.11 _b	5.93
Anticipated energy required by third task	14.89 _a	5.29	8.26 _b	4.74	15.49 _a	5.59	9.15 _b	5.08
Importance of conservation	7.72 _a	6.36	4.00 _b	5.27	4.01 _b	5.60	3.88 _b	3.71
Time in ice water	59.06 _a	49.58	101.54 _b	43.48	102.32 _b	52.17	128.80 _c	48.374

Note. $N = 93$. Means that do not share subscripts differ at $p < .05$ using the Tukey correction for multiple tests. Time in ice water was measured in seconds.

0.86, *ns*. This replicates the previous experiments that have found that although thought suppression is just as frustrating and difficult as solving math problems, thought suppression requires more self-control than solving math problems (e.g., Muraven et al., 1998). A power analysis suggested that we had sufficient power to detect a medium effect size ($d = 0.5$) approximately 76% of the time, which indicates that we should have been able to detect meaningful differences between the conditions, had any existed.

Consistent with the experimental design, participants viewed future tasks that required self-control as demanding more energy and effort than future tasks that were not described as requiring self-control. Participants in the future self-control condition reported that they expected the third task to require more energy than did participants in the no future self-control condition, $t(90) = 6.11$, $p < .001$. Likewise, participants who expected to exert self-control in the future expected to exert more effort on the third task, $t(90) = 5.70$, $p < .001$.

Dependent Measure

The time participants held their hand in the ice water was analyzed using a 2 (initial task) \times 2 (anticipation for the future) analysis of variance (ANOVA). Replicating previous research (Muraven et al., 1998), we found that individuals who exerted self-control in the first phase of the experiment tended to remove their hand from the water sooner than those who did not exert self-control initially, $F(1, 89) = 3.19$, $p < .07$. The main effect for future task was not significant, however, $F(1, 89) = 0.16$. Most important, the interaction between initial task and future task was also significant, $F(1, 89) = 4.24$, $p < .05$.

Several results from the post hoc tests reported in Table 1 should be noted. First, replicating previous research on self-control strength, participants who had to suppress their thoughts and did not anticipate self-control in the future removed their hand from the water sooner than participants who solved arithmetic problems and did not anticipate self-control in the future. Second, consistent with the conservation hypothesis, a focused contrast found that participants who suppressed their thoughts and expected to exert self-control in the future removed their hand from the ice water sooner than people in the other three conditions, $t(89) = 2.11$, $p < .05$. The length of time participants held their hand in the water

was normally distributed; thus, there was no restriction of range or ceiling effect. This is consistent with the argument that people are motivated to conserve self-control strength, and this desire to conserve is stronger among people who have recently exerted self-control.

Motivation to Conserve

Finally, we examined how the future task affected participants' perception and motivation for holding their hand in the ice water. As shown in the post hoc tests in Table 1, participants who had to exert self-control in the first part of the experiment and who expected to exert self-control in the future felt it was more important to conserve than did other participants.

There was also a correlation between how much participants were trying to conserve their energy for the third task and how long they held their hand in the ice water. Across the entire sample, participants who felt it was less important to conserve energy kept their hand in the ice water longer, $r(93) = 0.21$, $p < .05$. This is consistent with the argument that anticipating self-control in the future increases the value of remaining strength, and the stronger the motivation to conserve this strength, the more poorly the person performs on a test of self-control.

Discussion

The results of Experiment 1 indicate that anticipating the need for self-control in the future and exerting self-control in the past combine to influence current self-control performance. Individuals apparently anticipate self-control tasks and alter their behavior to conserve a limited resource. Moreover, participants who exerted self-control in the first part of the experiment and therefore should have depleted some of their strength were more concerned with conserving strength than were those who were not as depleted.

There was a relationship between desire to conserve and self-control outcome as well: The more they reported conserving strength, the more poorly participants performed on the test of self-control. These findings are consistent with the economic or conservation of resource model of depletion outlined earlier: Self-control performance may suffer because people are trying to

conserve what self-control strength they have, and the desire to conserve is stronger among people with less strength.

However, one shortcoming of Experiment 1 was that the future task involved either suppressing emotions while watching the comedy or simply paying close attention. Thus, it is possible that a variable unrelated to self-control (e.g., difficulty or effort) may have influenced participants' desire to conserve in Experiment 1. Moreover, expecting to watch a comedy may have had unexpected positive affective consequences, which could help replenish lost strength (Tice et al., 2005).

We designed Experiment 2 to address those concerns. In particular, if expecting to exert self-control in the future is indeed the critical factor, then individuals who anticipate a demanding task that does not require self-control in the future should perform equally well on a test of self-control as individuals who are not told about any future task. People in either of those conditions should perform better than people who expect to exert self-control in the future, even when that future self-control task does not seem any more unpleasant, harder, or difficult than the task that did not require self-control.

Experiment 2

Method

Participants

A total of 103 (57 male and 46 female) undergraduate students participated in the study in partial fulfillment of a psychology class requirement. Participants were tested in small groups. Each testing session lasted approximately 30 min.

Procedure

Upon arrival at the laboratory, participants were greeted by an experimenter and were seated in a cubicle in front of a computer without interacting with one another. They were told that the purpose of the experiment was to examine how individuals regulate attention and that they would be taking several different tests of attention. All instructions were presented on the computer, and the computer randomly assigned participants to condition at run time as well. Thus, the experimenter was unaware of participants' assigned condition and did not interact with participants during the course of the experiment.

Depletion phase. For the first task, participants were instructed to retype a short paragraph that appeared on the computer screen as quickly as they could. Participants could not see what they typed, although the computer recorded all keystrokes. The computer randomly assigned participants to one of two conditions. In the type-all-letters condition, participants retyped the paragraph as it appeared on the screen. In contrast, participants assigned to the no-*e*'s condition were told not to type any *e*'s or spaces as they retyped the paragraph. Following such a rule likely required the person to override the natural inclination to type every letter and therefore should have required self-control (Rieger, 2004). After typing the paragraph (the computer stopped timing when they typed the three letters in the last word), participants were then given the Brief Mood Introspection Scale (BMIS; Mayer & Gaschke, 1988) to assess their mood and arousal. They also completed a short manipulation check to assess their self-control efforts ("How much were you fighting against an urge on that task?" rated on a 7-point scale ranging from *not at all* to *very much* and "How much did you have to control yourself on that task?" rated on a 7-point scale ranging from *not at all* to *very much*). We also assessed whether the initial task differed in effort required ("Did that task require

much effort?" rated on a 7-point scale ranging from *definitely no* to *definitely yes*).

Future tasks. The computer then presented instructions to the participants about the next task, a test of attention regulation (see the following paragraph). The last paragraph of the instructions informed participants that after the test of attention regulation, they would be taking one final test. This final paragraph varied randomly across participants. One group of participants, future self-control, was warned as follows: "Immediately after this test, you will take a final test of performance. This test will require you to remember many numbers while being distracted." Concentrating in the face of distractions has been found to require self-control, and thus this task likely would require self-control. Another group, future hard problems, was advised as follows: "Immediately after this test, you will take a final test of performance. This test will require you to solve math problems of varying degrees of difficulty." Prior research (Muraven et al., 2002) suggests that most individuals find solving math problems difficult, unpleasant, effortful, and demanding, but that solving problems does not require overcoming a strong impulse. Hence, participants in this condition expected a difficult and demanding task in the future but did not expect to exert much self-control. Finally, there was a no-instructions condition. Participants in this condition were not informed about any future task.

Measurement phase. Participants then took the test of attention regulation. Numbers were flashed in rapid succession on the computer screen. Participants were told to press the space bar when the number 4 followed the number 6. The numbers were presented at an irregular interval (750 ms \pm 300 ms) and were on the screen for a relatively short time (250 ms \pm 100 ms). The entire trial lasted approximately 12 min. This task required a great deal of continuous concentration on participants' part—even a moment's distraction could lead to missing a number. This test has a long history of being used to measure problems with attention regulation (See, Howe, Warm, & Dember, 1995) and indeed has been used as a screening test for self-control problems (White et al., 1994). Participants who are trying to conserve self-control strength and hence are less likely to exert self-control may have trouble overriding the natural tendency of the mind to wander and hence miss more targets (have a lower hit rate) than participants who are less motivated to conserve strength.

Finally, after completing this second task, participants were given a brief manipulation check questionnaire to assess whether the groups differed in their perception of this task. In particular, participants were asked how difficult they thought the future task would be ("How difficult do you think the next task will be?" rated on a 7-point scale ranging from *very easy* to *very difficult*), how much the future task was a distraction ("How much did you think about what is going to happen next?" rated on a 7-point scale ranging from *very little* to *very much*), and how fun the next task would be ("Will the next task be fun?" rated on a 7-point scale ranging from *definitely no* to *definitely yes*). They also answered whether the future task would require self-control ("How much will you have to stop yourself during the future task?" rated on a 7-point scale ranging from *very little* to *very much*). Participants were then carefully debriefed by the experimenter. No participant reported awareness of the true nature of this experiment or the experimental hypotheses.

Results

Manipulation Checks

As shown in Table 2, there was no difference across groups on mood or arousal (all F s < 2.00, p > .10). The interaction between future task and typing condition also was unrelated to mood and arousal (F s < 1.50, p > .10). There was a main effect for typing condition for fighting against an urge, $F(1, 97) = 5.38$, p < .025, and how much self-control was exerted, $F(1, 97) = 6.61$, p < .01. Not typing *e*'s required more self-control than typing all the letters. The main effect for instructions and the interaction between in-

Table 2
Experiment 2: Responses on Key Variables Based on Initial Task and Expectation for Future Self-Control

Variable	Depleted						Not depleted					
	Future self-control		Future hard		No future (control)		Future self-control		Future hard		No future (control)	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Mood	1.92 _a	13.81	-1.47 _a	8.54	0.73 _a	12.38	0.23 _a	13.50	0.95 _a	9.38	1.38 _a	9.84
Arousal	24.16 _a	3.56	23.86 _a	7.31	22.73 _a	5.37	20.64 _a	4.05	22.04 _a	3.42	22.61 _a	3.88
Fight against an urge on first task	5.08 _a	2.12	5.42 _a	0.61	4.21 _a	1.83	3.23 _b	1.18	2.74 _b	1.88	3.00 _b	1.71
Self-control exerted on first task	4.38 _a	2.06	4.68 _a	1.70	3.94 _a	1.81	2.62 _b	1.56	2.32 _b	1.25	2.70 _b	1.46
Anticipated self-control on third task	5.54 _a	1.85	4.74 _b	1.85	4.13 _c	1.32	5.23 _a	1.64	4.79 _b	1.65	4.56 _b	1.37
Anticipated difficulty of third task	3.77 _a	2.28	3.37 _a	1.89	3.39 _a	2.08	2.92 _a	1.66	3.00 _a	2.19	3.81 _a	1.47
How distracting was third task?	4.08 _a	2.14	3.16 _b	1.95	3.96 _a	2.03	3.82 _a	2.30	4.58 _b	2.17	4.44 _b	1.90
How fun will the third task be?	2.23 _a	1.24	2.53 _a	1.65	3.09 _a	1.70	2.15 _a	1.21	2.68 _a	1.89	2.56 _a	1.21
Hits on concentration	20.23 _a	4.01	25.57 _b	3.78	25.39 _b	5.78	27.77 _c	5.35	27.68 _c	5.00	28.06 _c	5.57

Note. *N* = 103. Means that do not share subscripts differ at *p* < .05 using the Tukey correction for multiple tests.

structions and typing condition had no effect on how much self-control was required (all *F*s < 1.00, *p* > .10).

An examination of the manipulation check for the anticipated third task found few meaningful differences. The instructions to ignore distractors was perceived to require more self-control than the instructions to solve math problems or no instructions, *F*(2, 97) = 3.89, *p* < .05. Despite the difference in self-control required, the future task did not differ in how distracting it was, how difficult it seemed, or how much fun participants thought this future task would be—the main effect for typing condition and for anticipated task, and the interaction between those variables, was not significant (all *F*s < 2.00, *p* > .10). In short, the future task was perceived the same across groups, except in how much self-control it would require.

Dependent Measure

We conducted a 2 (initial task: type all, no *e*'s) × 3 (future task: demanding, self-control, none) ANOVA on second task performance, with targets found on the concentration task as the dependent measure (see Table 2). First, there was a main effect for initial task, *F*(1, 97) = 9.38, *p* < .005. Replicating previous work, individuals who exerted self-control in the first part of the experiment performed more poorly on the dependent measure than those who did not exert self-control. Participants who expected to exert self-control in the future also tended to miss more targets, although this result did not reach conventional levels of significance, *F*(2, 97) = 2.31, *p* < .10. These main effects were qualified by a significant interaction between initial task and future task, *F*(2, 97) = 5.17, *p* < .01.

To further explore the interplay between past exertion of self-control and future exertion of self-control, we first removed the participants who were not told of a future task from the analysis. When just the anticipate demanding task and anticipate self-control task groups were considered, the interaction between initial task and future task remained significant, *F*(1, 60) = 9.22, *p* < .005. Similarly, when participants who were told to expect a demanding task that did not require self-control in the future were omitted and participants who were not told about a future task were included, the interaction between past self-control effort and

future task was close to conventional levels of significance, *F*(1, 61) = 3.07, *p* < .08. Finally, when the participants who anticipated a task that required self-control were omitted and just the demanding-future-task and no-future-task groups were considered, the interaction between initial task and anticipated task was not significant, *F*(1, 73) = 2.01, *ns*. In other words, the effects were specific to expecting to exert self-control in the future and were not the product of merely anticipating a forthcoming task.

We also examined the relationship between the manipulation checks and performance on the vigilance task. Across the entire sample, expecting to exert more self-control in the future was negatively related to participants' performance on the vigilance task, *r*(103) = -.27, *p* < .05. On the other hand, the amount of effort participants expected to exert on the future task was not related to performance on the vigilance task, *r*(103) = -.14, *ns*, nor was the expected difficulty of the future task, *r*(103) = -.11, *ns*. Participants also reported that how distracting the final task was was not related to performance on the vigilance task either, *r*(103) = -.14, *ns*. Finally, how fun participants felt the future task would be was not related to targets missed on the vigilance task, *r*(103) = -.01, *ns*. In short, the critical feature of the future task appeared to be how much self-control it required, rather than distraction or simple effort demanded.

Discussion

The results of Experiment 2 replicated and extended the previous experiment. In particular, as in Experiment 1, participants who anticipated exerting self-control in the future and who exerted self-control in the past performed more poorly on a test of self-control than participants who did not exert self-control in the past and more poorly than participants who did not anticipate exerting self-control in the future. This implies that individuals are concerned with the amount of self-control they will have to exert in the future. It appears that the heightened desire to conserve resources, based on a depleted state and future demands, leads to diminished self-control performance.

To further disentangle whether these effects were merely due to anticipating a difficult task, we included three conditions: no future task, a task that would require self-control, and a difficult task that

did not require self-control. The results indicated that participants who expected a difficult task that did not require self-control did not differ from participants who did not expect any task in the future. Despite the differences in self-control performance, individuals who expected to exert self-control in the future did not believe that the task would be more unpleasant or difficult than participants who anticipated a difficult task that did not require overriding an impulse. Moreover, the groups reported thinking about the future task the same, which suggests the cognitive demands of the future task were equal across groups. In summary, the effects of expecting to exert self-control appear to make a unique and distinct contribution to self-control performance, as predicted by conservation of resource theories.

Experiment 3

Experiment 3 used slightly different methods than the previous experiments to test the conservation hypothesis. Rather than explicitly giving participants a task to expect in the future, we prompted participants to think about the amount of self-control demands they would expect to face in the coming hours. Thus, this experiment has greater ecological validity than the previous studies, as it tests whether anticipating naturally occurring demands in the future can also lead participants to perform more poorly on immediate tests of self-control.

In this experiment, participants completed a questionnaire assessing the amount of self-control demands that they anticipated dealing with after they left the experiment and before going to bed that night. Such an assessment should remind participants of the need to conserve strength and might lead to poorer self-control performance, especially among depleted individuals. To moderate the strength of this effect, some participants completed the questionnaire before their self-control was assessed, whereas others completed it after the main dependent measure. Presumably, there should be a strong, inverse relationship between anticipated future self-control demands and present self-control performance for participants who are reminded of those demands; the effect should be much smaller for those not reminded of future self-control demands. Moreover, previous exertion of self-control should moderate this effect: Individuals who have already exerted self-control should be the most sensitive to future self-control demands, especially when reminded of them. That is, self-control performance should be a function of anticipated self-control demands, cuing of those demands, and previous self-control exertion.

Method

Participants

Sixty-two undergraduate students (38 women and 24 men) received a partial course credit for their participation in Experiment 3. Each individual testing session lasted approximately 45 min.

Procedure

An experimenter who was unaware of the research hypotheses greeted participants. They were told that the purpose of the study was to investigate the relationship between eating and cognitive functioning. Participants did not know that their self-control performance was being evaluated.

Depletion phase. Participants were then presented with a plate of chocolate chip cookies and a plate of celery. Participants who were randomly assigned to the no-cookie condition were told that they were in the celery group. They were asked to eat at least one or two pieces of celery, but they should not eat any of the cookies. Participants in the no-celery condition were given similar instructions to sample a cookie but not to eat any celery. Previous research (Baumeister et al., 1998) found that cookies are much more tempting than vegetables and that it requires more self-control to resist eating cookies. Thus, participants assigned to not eat the cookies should deplete more self-control strength than participants assigned to not eat the celery. Following the first experimental tasks, participants completed the BMIS (Mayer & Gaschke, 1988) to assess their mood and arousal. They also completed a short manipulation check to assess whether conditions differed in unpleasantness ("How unpleasant was that task?") rated on a 30-point scale ranging from *very unpleasant* to *very pleasant*) and frustration ("How frustrating was that task?") rated on a 30-point scale ranging from *very frustrating* to *not frustrating at all*).

Future task. Half the participants then completed a 27-item measure of future self-control demands that they anticipated facing from the end of the experiment until they went to sleep that night. This instrument assessed a broad domain of self-control, including anger control ("I will have to control my temper"); the need to fight temptations to smoke, drink, or eat to excess ("I will have to resist the temptation to smoke"); and the need to regulate attention ("I will have to concentrate"). These items were rated on a 7-point scale with anchors of *very unlikely* and *very likely*; thus, higher scores indicate more future self-control demands. A factor analysis found that the items strongly loaded on one factor, and an examination of the factor loadings (using a scree plot) found that a single-factor solution was appropriate. This single factor, named Future Self-Control Demands, had excellent internal reliability (coefficient alpha was .91). The other half of the participants completed this questionnaire of future self-control demands after the dependent measure, so that they were not as aware of their future self-control demands while their self-control was measured behaviorally. The experimenter was aware of the order of the tasks but did not know participants' level of future self-control demands.

Measurement phase. Participants' self-control was then assessed using a stop signal task. The stop signal task is a cognitive test of inhibition that requires participants to respond as quickly as possible to a judgment task (de Jong, Coles, Logan, & Gratton, 1990; Logan & Cowan, 1984). On approximately 25% of the trials, a tone sounds, indicating that participants should inhibit their response. Previous research has found that performance on the stop signal task is positively related to self-control capacity. For example, children lower in self-control (such as children with attention deficit hyperactivity disorder; see Barkley, 1997b) are less able to stop themselves and perform more poorly on the stop signal task than children with greater self-control (Oosterlaan & Sergeant, 1996; Schachar & Logan, 1990; Schachar, Tannock, & Logan, 1993). Thus, the stop signal task is a well-established measure of self-control. Individuals who are depleted and conserving strength for a future task should perform more poorly on a stop signal task than those who are less depleted or not as motivated to conserve.

Following Oosterlaan and Sergeant (1996), participants were instructed to indicate the position of a square on a computer screen by pressing the appropriate key on the keyboard. They were asked to respond as quickly and as accurately as possible. From time to time, a tone would sound. Participants were asked to suppress their response (i.e., not to hit any key on the keyboard when they saw a square) whenever they heard a tone. All participants received standard instructions that appeared on the screen.

The task was composed of five blocks, each consisting of 64 trials. To familiarize participants with the task, the first block was the practice block. Participants were not informed that the first block was designed for practice only. After the third block was completed, the computer instructed participants to take a short break, close their eyes, and relax.

Auditory stop signals were presented randomly and occurred on 25% of the trials. As a means of controlling for individual differences in reaction times and differences in reaction time over the experiment, participants' mean primary reaction time (MRT; how quickly they responded to the square) was calculated for each block. The auditory stop signals were then presented 50, 200, 350, and 500 ms before the MRT calculated in the preceding blocks. Auditory stop signals were introduced at or after the presentation of a square on the computer screen.

Each trial began with the introduction of a fixation point that appeared in the center of the screen for 500 ms. Following the fixation point, a white square was presented for 1,000 ms. Within each block, the stimulus presentation was counterbalanced, such that (a) half of the squares appeared on the right side and half of the squares appeared on the left side of a computer screen; (b) auditory stop signals given 50, 200, 350 or 500 ms before a participant's MRT were presented with equal frequency; (c) auditory stop signals were counterbalanced across right and left presentation of the square; and (d) presentation of 50-, 200-, 350-, and 500-ms trials was randomized within each block. Participants' ability to stop themselves from responding was calculated for each stop signal time, based on the proportion of number of responses not made when the tone sounded.

Upon completion of the stop signal task, participants completed some additional questionnaires and were carefully debriefed using a modification of the funnel debriefing procedure (Chartrand & Bargh, 1996). None of the participants reported awareness that the tasks were related or that self-control was the primary focus of the study.

Results

Manipulation Check

Like the previous experiments, participants' BMIS arousal and mood did not differ across conditions; for arousal, not eat cookies, $M = 31.61$, $SD = 6.63$; not eat celery, $M = 33.94$, $SD = 4.73$, $t(60) = 1.61$, *ns*; for mood, not eat cookies, $M = 1.26$, $SD = 8.36$; not eat celery, $M = -1.42$, $SD = 7.56$, $t(60) = 1.32$, *ns*. The groups likewise did not differ in self-reported unpleasantness of the initial task (cookies, $M = 25.12$, $SD = 5.00$; celery, $M = 25.80$, $SD = 5.87$), $t(60) = 0.51$, *ns*, or frustration (cookies, $M = 24.41$, $SD = 6.31$; celery, $M = 25.63$, $SD = 5.82$), $t(60) = 0.80$, *ns*.

Most important, the two groups did not differ in their self-report of future self-control demands (cookies, $M = 98.10$, $SD = 27.11$; celery, $M = 105.33$, $SD = 26.18$), $t(60) = 1.06$, *ns*. Individuals who were told that they could not eat the cookies reported that they expected the same amount of self-control demands in the future as participants who could not eat the celery. Whether the assessment of future self-control demands occurred before or after the dependent measure also was not related to the amount of demands anticipated in the future, $t(60) = 0.43$, *ns*.

Dependent Measure

We focused on the most difficult stop signal delay: 50 ms prior to their typical response (longer offsets would occur closer to the appearance of the box on the screen, giving participants more time to stop themselves, and therefore required far less self-control). Using moderated multiple regression, we tested whether the proportion of responses not made when the tone sounded was related to the amount of self-control demands they anticipated that day (standardized), when they were cued into those demands (before or after the stop signal task), and the prior exertion of self-control (resist cookies or celery). The slope for the main effect of the initial task was close to conventional levels of significance, $B =$

-0.25 , $SE = 0.13$, $t(54) = 1.92$, $p < .06$, indicating that more depleted participants may have been less able to stop themselves on the stop signal task than the less depleted participants. The main effects for order of questionnaires, $B = 0.93$, $SE = 0.91$, $t(54) = 1.01$, *ns*, and self-demands, $B = -0.01$, $SE = 0.066$, $t(54) = 0.080$, *ns*, were not significant.

The two-way interaction between depletion and order of the questionnaire was significant, $B = -0.30$, $SE = 0.13$, $t(54) = 2.34$, $p < .025$. Depleted individuals reminded about future self-control demands performed worse as compared with those not reminded about future self-control demands. The two-way interaction between depletion and demands did not reach conventional levels of significance, $B = -0.16$, $SE = 0.09$, $t(54) = 1.75$, $p < .09$, but suggested depleted participants may perform worse when they had more demands in the future. The two-way interaction between order and demands was not significant, $B = 0.03$, $SE = 0.09$, $t(54) = 0.75$, *ns*.

These effects are modified by a nearly significant three-way interaction between depletion, amount of future demands, and order of the questionnaires, $B = -0.26$, $SE = 0.13$, $t(54) = 1.94$, $p < .057$. We then examined the simple relationship between future demands and self-control performance for each of the four groups (see Figure 1). Daily demands were nearly significantly related to self-control performance for participants who had to resist eating the cookies and who completed the self-control demand questionnaire before the stop signal task, $B = -0.007$, $SE = 0.003$, $t(54) = 1.83$, $p < .07$. The relationship was not significant for participants who had to resist eating the cookies and who completed the self-control questionnaire after the stop signal, $B = 0.004$, $SE = 0.003$, $t(54) = 1.21$, *ns*. Similarly, future demands were unrelated to self-control performance for participants who had to resist eating the celery, irrespective if the questionnaire came before, $B = 0.002$, $SE = 0.003$, $t(54) = 0.73$, *ns*, or after the stop signal task, $B = 0.001$, $SE = 0.003$, $t(54) = 0.18$, *ns*.

Put another way, the amount of self-control expected in the future was related to performance only when participants were depleted and those demands were made salient. As predicted by the conservation model, participants who were depleted, who anticipated more self-control demands in the future, and who were reminded of those demands performed more poorly on a test of self-control.

Discussion

This experiment replicated the results of the previous experiments using different methods of exerting self-control, measures of self-control performance, and future self-control demands. There was a relationship between self-control performance and anticipated future self-control demands for depleted participants when the future demands were made salient; this relationship was far weaker for depleted individuals when the future demands were not salient. Although there was a main effect for depletion (i.e., participants who had to exert self-control performed worse on the stop signal tasks than participants who did not have to exert self-control), this effect was moderated by future self-control demands. This suggests that depleted people may perform more poorly on tests of self-control because they are motivated to conserve strength for the future demands.

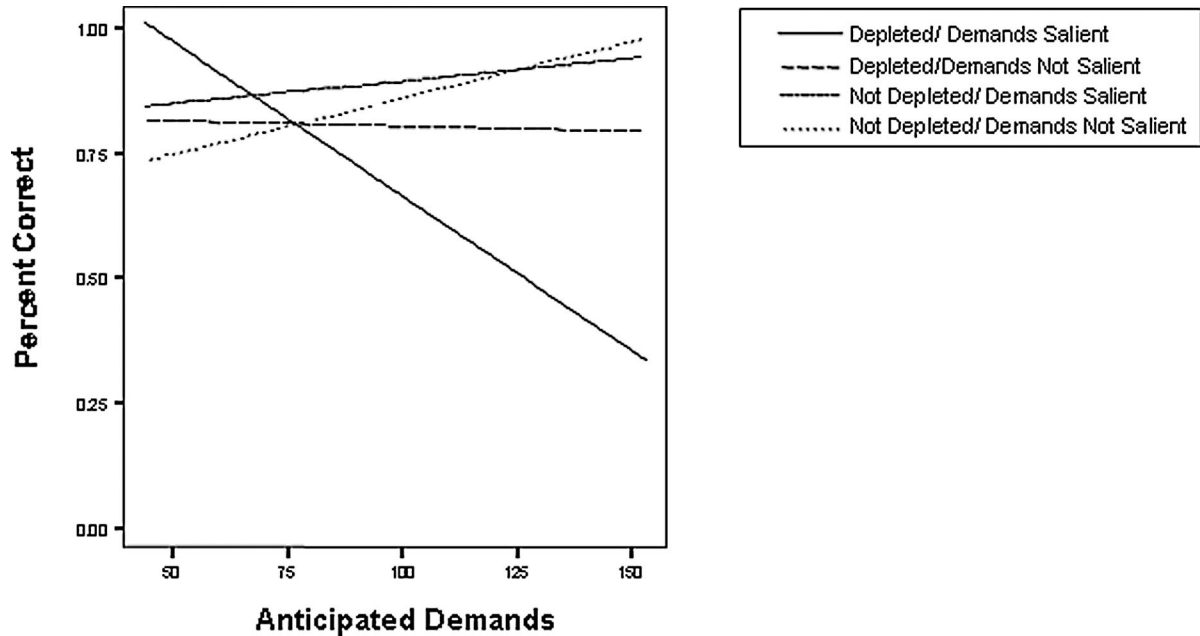


Figure 1. Experiment 3: Relationship between stop signal performance (proportion of responses inhibited when tone sounded) and future self-control demands, based on previous self-control exertion and order of presentation (measure of future self-control demands before or after stop signal task).

Experiment 4

Experiment 4 had several purposes. The first purpose was to use different tasks to replicate and generalize the results found in the previous experiments. As in the previous experiments, we predicted that depleted participants who anticipated exerting more self-control in the future should perform more poorly on a test of self-control than depleted participants who anticipated exerting little self-control in the future and more poorly than those who were less depleted.

The second purpose was to actually measure people's performance on a third task. That is, after participants' self-control performance on the main dependent measure was assessed, they then engaged in a third task. By measuring their self-control performance a third time, we hoped to get a sense of whether conservation is effective. Conserving energy can be a beneficial strategy, as it allows individuals to make optimal use of their limited resources. Hence, we predicted that if participants are saving energy for a third task, they should perform worse on the second task than those who are not as motivated to save strength. However, by saving strength, participants should perform better on the third task than those who were less motivated to conserve strength. There should be a trade-off between performance on the second and third self-control tasks, especially among those who expected that the third task would require self-control.

Finally, when the performance measure does not require self-control, the effects of exerting self-control in the past and expecting to exert self-control in the future should be eliminated. Put another way, if participants are motivated to conserve self-control resources (and those resources are depleted by the previous exertion of self-control), then performance on this non-self-control task should not be related to past or future self-control operations. On the other hand, if the effects

in the previous experiments are being driven by mood, arousal, or distraction, then it should not matter whether the task requires self-control or not: The effects will not be specific to tasks that require self-control. By comparing performance on a test that requires self-control with a test that does not require self-control, we hoped to test the specificity of self-control in the conservation model.

Method

Participants

A total of 152 undergraduate students (92 male and 60 female) participated in the study for extra credit or partial fulfillment of a psychology class requirement. Each testing session lasted approximately 30 min.

Procedure

The experiment was conducted on a computer, which presented all instructions to participants and randomly assigned them to a condition at run time. Upon entering the laboratory, the experimenter explained the participants' rights to them, had them sign a consent form, seated them in front of a computer, and started the program. Participants were not informed of the true purpose of the study or that the study involved self-control. Instead, they were told, via the computer, that the experimenters were investigating the relationship among several cognitive processes and that they would be completing several different tasks that measured various aspects of these processes.

Depletion phase. Participants' initial self-control demands were manipulated using a typing task, like that in Experiment 2. In particular, they were directed to retype a paragraph that was displayed on the computer screen. Half of the participants were instructed to type the paragraph as it appeared; the other half were instructed to retype the paragraph without using the letter *e* or the space bar. After typing the paragraph, they then completed a brief manipulation check to assess whether the conditions

differed in how much self-control was required (“How much were you fighting against an urge on that task?”) rated on a 7-point scale with anchors ranging from *not at all* to *very much*. Participants’ mood and arousal was also assessed using the BMIS (Mayer & Gaschke, 1988).

Future task. Next, the amount of self-control required by the third and final task in the future was manipulated. Participants were told by the computer that there were two more tests: a test of color-word identification (Stroop) and anagrams. They were told that the Stroop test would be next, followed by the anagrams. The instructions for the Stroop were the same for all participants, but the description of the anagrams differed across conditions and served as the manipulation of future self-control.

In particular, all participants read a brief paragraph explaining that previous research has found that students find anagrams difficult and challenging. The last sentence differed across conditions, however. Participants who anticipated a difficult task were told that they should expect to “think hard while working on this task.” Participants who anticipated self-control were told that they should expect to “work hard at overriding impulses while working on this task.” Thus, all participants expected a difficult task; what differed across conditions was the amount of self-control they expected to exert in the future. Participants’ perception of this future task was then assessed. In particular, they were asked about effort (“How hard do you think the third task will be?”), how unpleasant they thought that future task would be (“How unpleasant does the third task sound?”), and how much self-control they thought this future task would require (“How much do you think you will have to override an urge while working on the third task?”) rated on a 7-point scale ranging from *not at all* to *very much*.

Measurement phase. After they were told about this final task, their self-control performance was assessed using a Stroop task. Previous research (Wallace & Baumeister, 2002) found that performance on the Stroop entails self-control. Inhibiting the word to say the ink color is harder for participants lower in self-control capacity, and hence depleted individuals should take longer to report the ink color than would less depleted individuals. In the present experiment, the words were presented on the computer screen and participants had to report the ink color using the keyboard. Participants saw a total of 80 words. How long it took them to respond after the word appeared on the screen was measured by the computer. Incorrect responses were rejected by the computer. If participants took longer than 2 s to supply a correct answer, the time for that trial was recorded as 2 s. Less than 3% of all the data points were handled in this way; no single participant had more than four responses (5%) cut off.

In addition, to demonstrate that the effects are specific to tasks that require self-control, for half of the participants, the color words matched the font color. For the other half of the participants, there was a mismatch between the font color and the word. Presumably, the effects of exerting self-control in the past and anticipating self-control in the future should only affect performance on tasks that require self-control (mismatch condition); there should be no effect of future or past self-control on tasks that do not require self-control (match condition).

After completing the Stroop, participants completed one more manipulation check to assess how much they were conserving resources for the third task (“Were you conserving energy for the next task?”) and how much they thought about that next task (“How much did you think about the next task while working on that task?”), answered on a 7-point scale with anchors ranging from *not at all* to *very much*.

Final task. After the manipulation check, participants engaged in the anagram task. The anagrams appeared on the screen, one at a time. There were five anagrams in total, each consisting of six letters. Participants could click a button to indicate that they had solved the anagram or wished to quit working on that particular anagram. Most critically, the third and fifth anagrams were unsolvable. Working on frustrating and difficult tasks when the option to quit is available and salient requires overriding the desire to stop. Consistent with previous research on self-control (Muraven et al., 1998), how long participants worked on these impossible anagrams

served as a measure of self-control performance, with greater self-control indicated by longer effort.

After completing that task, participants were then carefully debriefed about their research experience by the experimenter. Participants reported having no awareness that the second task was the critical task, nor did they suspect that performance on the second task was affected by either the initial task or the future task.

Results

Manipulation Checks

The manipulation checks were analyzed using a 2 (typing instructions: type all vs. no *e*'s) \times 2 (future task: self-control vs. difficult) \times 2 (ink color word: match vs. mismatch) ANOVA. As shown in Table 3, mood and arousal did not differ across conditions, nor were any of the interactions significant (all F s $<$ 2.50, $p >$.10). For the amount of inhibition exerted on the initial (typing) task, there was a main effect of instructions, $F(1, 144) = 20.01$, $p <$.001. Not typing *e*'s required more self-control than typing all the letters. No other main effect or interaction was significant (all F s $<$ 2.00, $p >$.10).

Participants’ expectation of how difficult the future task would be did not differ across conditions (all main effects and interactions, F s $<$ 1.40, $p >$.10). The same was true for how unpleasant they thought the third task would be (all F s $<$ 1.25, $p >$.10). Thus, whether the future task required self-control or was merely difficult was unrelated to participants’ expectations of how difficult they expected the future task to be or how unpleasant the third task would be. Likewise, the instructions had no apparent effect on participants’ cognitions—they reported thinking about the future task the same amount (all F s $<$ 1.10, $p >$.10). Hence, the future task was no more distracting when it required self-control than when it did not.

Participants did feel that the future task that was described as requiring self-control would require more restraint than the future task that was described as requiring thinking hard, $F(1, 144) = 4.01$, $p <$.05. No other main effect or interaction was significant for this variable, however (F s $<$ 2.50, $p >$.10).

Stroop Performance

Group differences. Participants’ performance on the Stroop task was analyzed using a 2 (typing instructions: type all vs. no *e*'s) \times 2 (future task: self-control vs. difficult) \times 2 (ink color word: match vs. mismatch). The time it took participants to respond to the 80 words was normally distributed; the score distribution for the match and no match was the same (although the means differed). As would be expected, there was a main effect for ink color-word match, $F(1, 144) = 20.83$, $p <$.001. It took participants longer to indicate the ink color when the word did not match the ink color than when it did. The main effect for typing instructions, $F(1, 144) = 0.97$, *ns*, or for the future task were not significant, $F(1, 144) = 1.12$, *ns*. There was no interaction between typing instructions and future task, $F(1, 144) = 0.50$, *ns*, nor between future task and Stroop instructions, $F(1, 144) = 0.25$, *ns*. The interaction between Stroop and typing instructions was significant, $F(1, 144) = 3.93$, $p <$.05. Individuals who had to exert self-control in the first part of the experiment took longer to respond to mismatches between word and ink color than to

Table 3
Experiment 4: Responses on Key Variables Based on Initial Task and Expectation for Future Self-Control

Variable	Depleted				Not depleted			
	Future self-control		Future hard		Future self-control		Future hard	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Mismatch Stroop								
Mood	2.89 _a	13.85	-3.00 _a	1.11	4.15 _a	4.85	-1.08 _a	9.67
Arousal	19.14 _a	2.98	22.26 _a	3.52	20.60 _a	6.25	20.81 _a	5.22
Inhibition required	4.30 _a	1.32	2.45 _b	1.04	4.46 _a	1.61	2.92 _b	1.56
Future self-control	4.56 _a	1.94	4.14 _{a,b}	2.01	4.92 _a	1.61	3.00 _b	1.91
Future difficult	5.89 _a	1.54	5.09 _{a,b}	2.12	5.38 _{a,b}	1.94	4.83 _{a,b}	2.62
Save energy for future	4.22 _a	1.30	3.17 _b	1.94	1.86 _c	0.38	2.33 _{b,c}	1.44
Distracting thoughts about future	4.56 _a	1.94	4.64 _a	2.01	4.92 _{a,b}	1.61	5.00 _{a,b}	1.91
Future unpleasant	3.22 _a	1.39	3.73 _a	1.74	3.15 _a	1.28	3.58 _a	1.78
Stroop	114 _a	17.5	104 _b	15.2	91 _c	11.8	94 _c	13.2
Time on anagrams	187 _a	71.8	107 _b	57.5	195 _a	91.3	151 _{a,b}	165
Match Stroop								
Mood	6.17 _a	7.70	2.20 _a	10.6	0.67 _a	8.90	-1.14 _a	9.78
Arousal	25.78 _a	4.35	20.76 _b	6.14	23.30 _b	2.87	20.66 _a	4.99
Inhibition required	3.33 _{a,b}	1.86	3.20 _a	1.64	4.44 _a	2.00	2.71 _b	2.36
Future self-control	5.67 _a	1.37	3.20 _b	1.79	4.44 _c	1.74	3.29 _b	1.98
Future difficult	5.17 _{a,b}	2.56	4.60 _b	1.52	5.44 _a	1.51	5.43 _a	2.44
Save energy for future	4.85 _a	1.21	3.20 _b	0.45	3.56 _b	1.33	3.55 _b	1.92
Distracting thoughts about future	5.67 _b	1.37	5.20 _{a,b}	1.79	4.44 _a	1.74	5.29 _{a,b}	1.98
Future unpleasant	3.33 _a	1.86	3.80 _a	1.10	3.22 _a	1.48	3.43 _a	1.99
Stroop	86 _a	11.6	82 _{a,b}	13.7	76 _b	12.8	81 _{a,b}	8.22
Time on anagrams	118 _a	19.9	142 _a	71.3	163 _a	47.4	233	85.0

Note. *N* = 152. Means that do not share subscripts differ at *p* < .05 using the Tukey correction for multiple tests. Stroop and time on anagrams were measured in seconds.

matches. This suggests that prior exertion of self-control only affects tasks that require inhibition and has no effect on tasks that do not require inhibition. Finally, the three-way interaction was significant, $F(1, 144) = 5.71, p < .025$ (see Table 3).

To best understand this interaction, we examined the effects of ink color-word match and mismatch separately. For the match condition, the main effect for future task, $F(1, 73) = 0.08, ns$, and typing instructions, $F(1, 73) = 0.10, ns$, as well as the interaction between these terms, $F(1, 73) = 1.00, ns$, were not significant. When a task does not require self-control, the past exertion of self-control or the future exertion of self-control has no effect.

A very different pattern emerged for the mismatch condition. Although the main effect for future instructions was not significant, $F(1, 73) = 1.06$, the main effect for typing instructions was significant, $F(1, 73) = 8.61, p < .01$. Replicating previous work (e.g., Wallace & Baumeister, 2002), individuals who were depleted performed more poorly on the Stroop task as compared with individuals who were not. Finally, consistent with the conservation hypothesis, there was an interaction between future task and previous exertion of self-control, $F(1, 73) = 6.97, p < .025$. A focused contrast indicated that participants who exerted self-control in the past and who expected to exert self-control in the future performed more poorly on the Stroop task compared with the other three conditions, $t(73) = 3.56, p < .001$.

Motivation to conserve. Participants were asked how much they were trying to save energy for the third task. The typing

instructions had no effect on conservation, $F(1, 144) = 1.25, ns$, nor did the future task, $F(1, 144) = 0.05, ns$. However, the interaction between these two terms was significant, $F(1, 144) = 7.44, p < .01$. People who exerted self-control in the past and who expected to exert self-control in the future were much more motivated to conserve energy than participants who did not exert self-control.

To test the contribution of the motivation to conserve on Stroop performance, we conducted a moderated multiple regression. There was a main effect for Stroop condition (match vs. mismatch), $B = 14.4, SE = 4.81, t(148) = 2.99, p < .001$, which merely indicates that it took participants longer to read the mismatched than the matched Stroop words. The overall effect for self-reported motivation to conserve was not significant, $B = 1.99, SE = 1.04, t(148) = 1.44, ns$. The interaction between Stroop condition and motivation to conserve was significant, however, $B = 2.09, SE = 1.04, t(148) = 2.01, p < .05$. An analysis of the simple slopes found that the relationship between motivation to conserve and Stroop performance was significant for participants who saw Stroop words that did not match the ink color, $B = 1.31, SE = 0.61, t(148) = 2.17, p < .05$. The relationship between motivation to conserve and Stroop performance was not significant for participants who saw the matching Stroop words, however, $B = -1.29, SE = 1.27, t(148) = 1.01, ns$. The more they were trying to conserve, the longer it took participants to say the Stroop words in the

mismatch condition. Conservation had no effect on tasks that did not require self-control, however.

Anagram Performance

Finally, we examined participants' performance on the third task: persistence on impossible anagrams. The main effect for initial self-control was significant, $F(1, 144) = 10.82, p < .01$. Depleted individuals persisted less on the anagrams. There were no main effects for Stroop or future self-control (all F s $< 0.54, ps > .10$). The two-way interaction between Stroop condition and future self-control was significant, $F(1, 144) = 14.75, p < .01$. The two-way interactions between Stroop and depletion, $F(1, 144) = 1.87, ns$, and depletion and future self-control, $F(1, 144) = 1.77, ns$, were not significant, however. The three-way interaction between initial self-control task, Stroop condition, and expectation for the future was significant, $F(1, 144) = 4.25, p < .01$.¹ Because of the relative complexity of this interaction, we examined the means separately for the match versus mismatch Stroop groups.

In the mismatch group (ink color did not match the color word), the main effect for initial task, $F(1, 73) = 0.05, ns$, and for the future task, $F(1, 73) = 0.00, ns$, were both not significant. The interaction between these terms was significant, however, $F(1, 73) = 6.65, p < .025$. Examining the means (see Table 3) indicates that initially depleted participants who did not expect to exert self-control in the future quit working on the anagrams sooner than participants in any other condition, which was confirmed by focused contrast $t(76) = 2.62, p < .025$. This suggests they spent all their resource on the initial two tasks, which led to reduced persistence on the anagrams. On the other hand, participants who were initially depleted but expected to exert self-control in the future performed as well as participants who were not depleted. This could be the result of conservation—they knew about the future task, so they saved resources for it and hence performed better on it.

When the ink color matched the word, there was no main effect for future tasks, $F(1, 73) = 0.03, ns$. However, the main effect for initial self-control task was close to conventional levels of significance, $F(1, 73) = 3.09, p < .08$. The interaction between future task and initial task was not significant, $F(1, 73) = 1.00$. Because the matched Stroop task does not require self-control, these results replicate previous work on depletion: Individuals quit working on self-control tasks sooner if they exerted self-control in the past. It also should be noted, however, that individuals who were not depleted, did not expect to exert self-control in the future, and saw matching Stroop words performed better than those in all other conditions. This may be because these individuals were the least depleted by any task and were the least concerned about the future and hence had "energy to burn."

Trade-Offs

Overall, then, participants appear to have been making a trade-off between the Stroop and anagram tasks, especially when expecting that the anagrams would require self-control. When warned about the future task, depleted participants reduced their efforts greatly (see the results for the Stroop task), which preserved some resources for the final task. Using multiple regression, we found that the relationship between Stroop performance and per-

sistence on the anagrams was not significant, $B = 1.81, SE = 1.44, t(148) = 1.26$. There also was no effect for Stroop condition, $B = 1.33, SE = 0.84, t(148) = 1.59, ns$. However, consistent with our theory of conservation, the interaction between Stroop condition and Stroop performance was significant, $B = 0.42, SE = 0.20, t(148) = 2.15, p < .05$. An analysis of the simple slopes found that in the mismatch Stroop condition, there was a relationship between Stroop and anagram performance, $B = 0.89, SE = 0.43, t(148) = 2.07, p < .05$ (because long persistence but short Stroop times reflect better self-control, the direction of the relationship is positive). In the matching Stroop condition, this relationship was not significant, $B = -1.02, SE = 0.80, t(148) = 1.28$. In other words, better self-control on the Stroop was associated with worse self-control on the anagrams. When the Stroop task did not require self-control (the ink matched the word color), this relationship was not found, however. This indicates that participants are trading better self-control performance on the Stroop for worse performance on the anagrams.

Discussion

As in the previous experiments, participants who exerted self-control in the first part of the experiment and who anticipated exerting self-control in the future performed worse on an intervening measure of self-control. Moreover, this poor performance was limited to tasks that actually required self-control. This appears to reflect the desire to conserve resources for the future, rather than a general decline in performance due to mood, arousal, frustration, or distraction.

Participants' performance on the anagrams also was consistent with the conservation hypothesis. In particular, when the second task did not require self-control (the ink matched the word color), performance on the final task was merely related to how much self-control the first task required. This result replicated previous work on self-control strength with the addition of an intervening task. When the second task required self-control (there was mismatch between ink and word color), performance on the third task suffered, unless the individual conserved resources (at the cost of hurting performance on the second task).

This experiment went beyond the previous experiments by showing that conservation appears to be a reasonable and successful strategy. There was a relationship between reports of conserving energy on the second task and performance on the third task. Although individuals who conserved energy performed worse on the second task, they actually did better on the third task as compared with individuals who were less motivated to conserve

¹ It might be argued that analysis of persistence on the insoluble items should control for speed of solutions on soluble items. However, two factors counter this argument. First, there is evidence that depletion also impairs performance on soluble anagrams (Baumeister et al., 1998). Second, a substantial number of participants failed to solve, or solved incorrectly, one or more soluble items. Consistent with Baumeister et al. (1998), the incorrect/missing solutions did not occur at random, but related to experimental condition, $\chi^2(7, N = 152) = 13.2, p < .05$, because depleted participants (especially those who anticipated self-control in the future and who worked on the mismatching Stroop) were especially likely to not answer or give the incorrect solution to the solvable anagrams. For these reasons, such a control appeared to represent an overcorrection.

self-control strength. Indeed, there is evidence of a trade-off between Stroop and anagram performance, at least for those who were told to expect self-control in the future. These results further imply that self-control is a resource that can be conserved for the future and allocated among tasks, based on individually determined priorities.

General Discussion

The results of these four experiments suggest that self-control performance is related to how much self-control participants exerted previously and the amount of self-control they expect to exert in the near future. In particular, people who exerted self-control in the recent past and who anticipated exerting self-control in the near future performed more poorly on a test of self-control than those who did not exert self-control recently or those who did not anticipate exerting self-control in the future.

These results are consistent with theories of conservation of limited resources. Exerting self-control may deplete a limited resource needed for self-control, which heightens individuals' desire to conserve what remains. This motivation to conserve is intensified by the anticipation of future demands. Indeed, secondary analyses found that participants whose self-control strength was depleted reported being more concerned with the future task and reported conserving more strength when this future task required self-control. Overall, the more motivated they were to conserve strength, the poorer they performed on immediate tests of self-control.

The final task in Experiment 4 suggests that conservation may be a useful policy for managing a limited personal resource when there are future demands. As was found in the previous experiments, individuals who reported conserving energy performed more poorly on the intervening task. There is evidence that they were engaged in a trade-off: Worse performance on the second task was compensated for by better performance on the last task. Thus, limiting how much energy is exerted was related to better performance on future demands, even though it appeared to hurt performance on the intervening tasks.

These experiments can also help explain the previously established but puzzling result that merely anticipating a stressor in the future can lead to a loss of self-control (Spacapan & Cohen, 1983): The desire to conserve resources for future demands is enough to lead to poorer performance in the present. There was no main effect for future demands in the present experiments; it only interacted with self-control in the past. Less depleted people likely need a very good reason to conserve, as they are less sensitive to future demands than are more depleted individuals. If we used a more powerful future task (such as putting one's hand in cold water, as done in Spacapan & Cohen, 1983), nondepleted participants also may have conserved strength.

Overall, the results imply that the willingness to use further self-control resources drops after people exert self-control. This can be contrasted with an alternative model that posits self-control becomes more difficult and effortful when people are depleted, much like one must work harder to get water out of a well as it dries up. Because future demands should affect the willingness to use self-control resources, by making the remaining resources more valuable without making present self-control more difficult, the present study clearly supports the first alternative: Depletion

increases individuals' motivation to conserve self-control resources. Hence, it appears that the reason self-control fails, especially after the previous exertion of self-control, is because people become more unwilling, and not less able, to exert self-control.

These experiments help illuminate the inner workings of self-control strength. It appears that self-control strength is treated like any other limited, valued, and slow to replenish resource: the less one has, the more one values what remains (as predicted by the economic law of diminishing marginal utilities). This motivation to conserve the self-control strength resource is consistent with other theories of the management of limited resources (Hobfoll, 2002) and can help explain why self-control fails: The more strength is depleted, the less people want to expend what strength remains. This also explains why external motivators can help encourage individuals to overcome depletion (Muraven & Slessarova, 2003)—concerns about the present task are more important than concerns about the future when one is given a strong incentive.

Finally, the idea of protecting or conserving strengths, energies, and other resources underlies many theories of the management of limited resources (Hobfoll, 2002). We believe that adding perceptions of future demands may be an important component of how people treat these resources. This also points to other variables that have to be examined in relationship to self-control strength. For example, we would expect the conservation effect to be larger the more a person values the future tasks, especially relative to any intervening task. Individual differences in self-management and awareness of self-control may also moderate the overall effect.

In conclusion, people are concerned with conserving their limited resources, especially when they expect to exert self-control in the future. This conservation leads to poorer self-control performance. Individuals lower in that resource, because of previous demands, should be particularly concerned with future demands and conservation. Thus, self-control fails not because people deplete all their resources but because they are concerned with having enough of the resource for the future. Conservation of limited resources, due to anticipated demands in the future, can lead to poorer self-control. This is a paradox of self-regulation: Human forethought and desire to exert self-control can lead to a breakdown of self-control in certain circumstances.

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