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Self-Regulation: A Challenge to the Strength Model

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Previous research suggested that an individual's capacity to self-regulate is limited, and easily depleted. The strength, or resource, model posits that self-regulation operates like a muscle, fatiguing after use and requiring rest. We attempted to replicate studies that supported this model. In Experiment 1, participants completed the Stroop task (requiring self-regulation), and then squeezed a handgrip exerciser as long as they could (a measure of self-regulatory depletion). In Experiment 2, participants were instructed NOT to think about a white bear as they wrote down their thoughts; depletion was then measured by time working on difficult anagrams. Self-regulatory depletion was not evident in either study. A new model for understanding the key psychological process of self-regulation may be needed.

The self is often conceptualized as the executive agent of the personality, responsible for regulating an individual's activities (see, for example, Baumeister, Bratslavsky, Muraven & Tice, 1998). This sometimes involves suppressing or over-riding immediate impulses or needs, and choosing a behavior that is more appropriate to the individual's long-term goals. Research on *self-regulation* has focused on the individual's capacity to monitor and modify behavior, cognition, and affect (and, sometimes, the individual's environment), in order to achieve a goal (Efklides, Niemivirta & Yamauchi, 2002). The latter authors point out that self-regulation has been seen in the research literature as relevant to various lines of research, including metacognition, achievement goals, intrinsic motivation, action control, appraisal processes, autonomy and self-determination in goal-setting, and cognitive or metacognitive strategy use in the implementation of goals.

There are definitional and conceptual issues to be clarified in research on self-regulation. As Boekaerts, Pintrich, and Zeidner (2000) note in their edited volume *Handbook of Self-Regulation*, "self-regulation is a very difficult construct to define theoretically as well as to operationalize empirically" (p. 4). Their *Handbook* presents multiple definitions of self-regulation, and the editors' conclusions include recommendations that a "common theoretical framework and nomenclature of constructs" be developed through future research.

One of the areas in need of clarification is the relationship between self-regulation and self-control. One distinction between the terms was made by Diaz, Neal, and Amaya-Williams (1990, as cited in Barkley, 1997); these authors construe self-control rather narrowly, as "adevelopmentally earlier form of self-regulation in which a child simply repeats and then obeys an adult command in the absence of the caregiver" (as described by Barkley, 1997, pp. 55-56). These authors see self-regulation, on the other hand, as "more complex behavior involving self-generated plans and flexible adaptation to the changing demands of a task" (as described by Barkley, 1997, p. 56).

Another distinction between self-regulation and self-control was implied by Baumeister and colleagues (1998) in discussing the results of one set of studies. These authors state that "some internal resource is used by the self to make decisions, respond actively, and exert self-control" (p. 1263). In this sense, self-regulation might be seen as the broader term (the internal resource), including self-control as well as active responding and decision-making.

In the same article, however, Baumeister and colleagues use the terms "self-control" and "self-regulation" interchangeably at times, making no clear distinctions between them, as do many other studies investigating the strength model (Baumeister et al., 1998; Baumeister, Heatherton, & Tice, 1994; Baumeister & Mick, 2002; Baumeister et al., 2000; Muraven et al., 1999; Muraven et al., 1998; Vohs & Heatherton, 2000). Russell Barkley, in *ADHD and the Nature of Self-Control* (1997), also uses the two terms interchangeably, noting that this has been the practice in the previous literature in that area. The term "self-control" is being interpreted by these authors in a broad sense, and is not seen as equivalent to impulse control (although the latter is clearly one part of self-regulation or self-control). According to Baumeister and Mick (2002), both self-regulation and self-control "refer to the self's capacity to alter its own states and responses" (p. 670-671).

It is beyond the scope of the present paper to resolve these conceptual issues; we will consistently use the term “self-regulation”, both because it seems more appropriate to the broad processes of interest to us, and also because this is the term used more often in previous studies in this area.

Self-regulation appears to be central to effective functioning in a number of ways — e.g., in impulse control, time management, and coping with emotions or stress.Many clinical conditions, such as anxiety, depression, or attention-deficit/hyperactivity disorder, may be viewed as limiting and restricting the individual’s ability to self-regulate and cope with everyday challenges and stress (see, for example, Barkley, 1997). Clarifying the nature of this active self, then, is of paramount importance for understanding a variety of phenomena related to educational and clinical contexts, as well as everyday functioning, and has implications at both personal and societal levels.

Some researchers have suggested an explanation for the observation that individuals often fail to self-regulate at times when self-regulation would be to their advantage. According to the *strength model* (also known as the *ego-strength model* or *resource model*),self-regulation might operate like a muscle that fatigues after use and then requires rest. The strength model posits that various acts ofself-regulation (cognitive, emotional, and behavioral) all draw upon one, limited supply. Baumeister, Muraven and Tice (2000) concluded that all acts involving self-control, volition, or initiative rely on this resource. In addition, the strength model proposes that this resource is easily depleted (Muraven, Tice & Baumeister, 1998).

The strength model has found some support in the literature; in a number of studies, when individuals were asked to engage in tasks involving self-regulation, their ability to self-regulate in subsequent activities significantly declined (Baumeister et al., 1998; Kahan, Polivy & Herman, 2003; Muraven et al., 1998; Vohs & Heatherton, 2000). In a similar way, with longer tasks demanding self-regulation, performance has been found to decline over time (Smit, Eling, & Coenen, 2004). This depletion of self-regulatory capacity was reported across a variety of tasks in physical, intellectual, and emotional domains. Other research has suggested that this resource—again, like a muscle—may be strengthened with certain types of practice (Muraven, Baumeister & Tice, 1999).

The present studies attempted to replicate and extend the findings of previous research related to the strength model. In the first experiment, we utilized a new approach to the manipulation of self-regulation, a computerized version of the Stroop Color and Word Test (Golden, 1978). (The Stroop task has since been used to manipulate "energy resources" in another study; see Wallace and Baumeister, 2002). Requiring considerable conscious effort, the Stroop task would clearly be expected to draw on self-regulatory capacity. The experimental group worked on Stroop (and related) tasks for approximately 15 minutes, while the control group performed a more automatic computer task for the same amount of time. A simple handgrip exerciser was used to assess self-regulatory capacity (as used in previous research – see Muraven et al., 1998) before and after the computer tasks; participants were asked to squeeze the exerciser and hold it for as long as they could. Depletion of self-regulatory resources was expected to be evident for the experimental group in the form of significantly shorter handgrip times after working on the Stroop task.

In the second experiment reported here, having failed to replicate and extend the previous research, we attempted a more literal replication of one of the early studies in this area (Muraven et al., 1998). Self-regulatory capacity was challenged in the experimental group by instructing them to **not** think about a white bear during a free-form writing exercise. Following this experimental manipulation, time spent working on a set of very difficult anagrams served as the dependent measure of self-regulatory capacity. Although the anagrams we used were actually solvable rather than unsolvable (as in Muraven et al., 1998), most were very difficult and, in fact, very few were ever solved by participants; thus, a similar persistence in the face of frustration was required. Muraven and colleagues found that those receiving the self-regulatory challenge spent significantly less time working on unsolvable anagrams than participants in the other conditions, and we expected to confirm these findings in Study 2.

Study 1

In an attempt to replicate and extend prior findings demonstrating depletion of self-regulatory capacity, we utilized the Stroop Color and Word Test (Golden, 1978) to manipulate that capacity. The Stroop task produces a "color-word interference effect" (Golden, 1978). That is, the stimulus (e.g., the word RED printed in blue letters) tends to lead automatically to a reading response, while the instructions are to name the color of the letters. This task requires considerable conscious effort, and was thus expected to draw on self-regulatory capacity. Handgrip time was measured before and after the Stroop manipulation for both control and experimental groups. Results were analyzed using a two-by-two factorial ANOVA, with the within-subjects variable of handgrip time, and the between-subjects variable of condition (group). It was hypothesized that there would be a significant interaction effect between condition and time, showing that the experimental group experienced greater self-regulatory depletion than the control group.

Methods

Participants.

69 undergraduates (7 males and 62 females) enrolled in a college in the northeastern U.S. volunteered to participate in this study. Participants ranged in age from 18 to 47 years, with a mean age of 21.40 years. They were predominantly Caucasian in ethnicity, with very small numbers of participants from a few other ethnic groups. Most of the volunteers received partial credit toward psychology courses (an alternative assignment was also provided in these courses), while a few volunteered without receiving credit. Participants were treated in accordance with the "Ethical Principles of Psychologists and Code of Conduct" (American Psychological Association, 2002).

The first 55 participants were randomly assigned to the experimental or control group, and after that, the balance was assigned to the experimental group (experimental group N = 42; control group N = 27). The two groups were very similar in age (experimental group M = 21.45 years, control group M = 21.37 years) and in ethnicity. There were a few more males in the experimental group (5 in experimental group, 2 in control group).

Procedures.

Participants were seen individually for a session averaging about 40 minutes in length. After the informed consent process, the participants were asked to complete a brief demographic information form and two measures related to another aspect of our research (a 40-item measure of attention-deficit disorder symptoms and a 90-item measure of general psychological distress). Participants were then given the handgrip exerciser (consisting of two plastic handles held together by a metal spring) and a small cloth ball, and they were instructed to insert the ball between the handles and hold it for as long as they could; when the ball fell, their time was recorded. According to Muraven et al. (1998), this task has been shown to be almost completely an indicator of self-control, rather than of bodily strength; it requires rather intense concentration to maintain steady tension. Similar to the procedures in Muraven et al. (1998), the ball was used to obtain a more precise measure of when the handgrip tension was released. This handgrip time, in seconds, was the pre-test measure of self-regulatory capacity. Participants were given the opportunity to shake out or stretch their hands.

Experimental participants worked on a computerized version of the Stroop task for approximately 15 minutes. Specifically, we designed a custom setup of the "Automatic Processing" experiment from the *Laboratory in Cognition and Perception* by C. Michael Levy and Sarah Ransdell (copyright 1999, Psychology Software, Inc.). Participants were instructed to respond by pressing "R" for red, "G" for green, and "B" for blue (we labeled the 1, 2, and 3 keys of the number keypad "R", "G", and "B", respectively, for convenience of responding); they were asked to work as quickly as they could, but were allowed 60 seconds to respond to each item.

For the experimental condition, there were 100 trials in which "red", "green", or "blue" was presented, one at a time, in an incongruent color, and participants were required to respond with the *color* of the letters. This involves the color-word interference effect, so that participants were challenged to inhibit their automatic response (of reading the word), to focus attention instead on the color, then to decide on and make the correct motor response (all drawing on self-regulatory resources). There was also a block of 100 trials where experimental participants were instructed that when the word was surrounded by lines that formed a box, they were to respond with the *color* in which the word was presented, and if there was no box, they were to respond with the *meaning* of the word. (Participants were given a sheet with these instructions to keep in front of them for reference.) This "memory load" block also involves the color-word interference effect, but adds demands on attention and memory; it was thus expected to tax participants' self-regulatory resources to an even greater degree. These blocks of trials were embedded in shorter blocks of other, similar tasks (responding with the *meaning* of a word printed in black, in a congruent color, or in an incongruent color). We expected that alternating tasks and instructions in this way would add complexity to the cognitive demands, further depleting self-regulatory resources.

Control participants performed similar, but more automatic, tasks on a personal computer for approximately 15 minutes [e.g., simply reporting the *color* of symbols (XXX) or simply reporting the *meaning* of a word printed in black or in a congruent color]. In this way, control participants were required to attend to similar computer stimuli and to make motor responses, just as the experimental group did, for approximately the same length of time. The effects of simple fatigue would thus be expected to be comparable for both groups. The difference was expected to be in the use of self-regulatory resources (inhibiting the automatic response, focusing attention, and remembering the instructions) in the experimental condition.

When the computer tasks were completed, all participants were again asked to squeeze and hold the handgrip, and handgrip time was recorded (post-test measure of self-regulatory capacity). Participants were then asked to respond to a few questions asking about their experience of the session. Lastly, they were debriefed and thanked, and they had a chance to ask questions and make comments.

Results

To check on our manipulation of self-regulatory resources in the experimental group, we reviewed the accuracy of participants' computer responses. For all experimental participants, accuracy was 90% or higher for more than half of the blocks; for most of these participants, accuracy was in the 90's for all blocks except the "memory load" block. Accuracy in the "memory load" block tended to drop to low levels, returning to very high levels in subsequent blocks. This drop is thought to be a reflection of the difficulty of that particular task. It appears that experimental participants overall were very much engaged in the tasks, and resource depletion would thus be expected for them.

Based on the strength model, it was predicted that there would be an interaction between condition and time, showing depletion of self-regulatory resources in the experimental group that exceeded any depletion in the control condition. A two-way analysis of variance failed to reveal the predicted interaction effect between condition and time, $F(1, 67) = .202$, $p = .654$.

In addition, there was no main effect for time, $F(1, 67) = .142$, $p = .708$. That is, for participants as a whole, handgrip times did not change significantly from pre-test to post-test. Lastly, there was no main effect for condition, $F(1, 67) = .150$, $p = .699$, suggesting that experimental and control groups were not significantly different in handgrip times. Standard deviations were large for pre- and post-measures in both groups, showing great variability in participants' handgrip times (see Table 1).

A series of questions asked at the end of the session assessed participants' perceptions of their own effort, focus, and self-control (all relevant aspects of self-regulation) in the second handgrip task. (E.g., "I stayed focused on squeezing the handgrip about as well as I could"; "I didn't really mean to let go of the handgrip when I did") A *t*-test revealed no significant differences between groups in mean responses to these items.

Study 2

Results of Study 1, which failed to confirm and extend findings from previous research, led us to try a more direct replication of one of the first studies in this area. Following Muraven and colleagues (1998), Study 2 involved manipulating self-regulation by instructing participants NOT to think about a white bear while writing down their thoughts. Self-regulatory capacity was then measured through the time participants were willing to spend working on difficult anagrams. A simple one-factor, between-subjects design was used in Study 2.

Methods

Participants.

76 undergraduates (68 females and 8 males) enrolled in a college in the northeastern U.S. volunteered to participate in this study. Participants ranged in age from 18 to 52 years, with a mean age of 22.39 years. They were predominantly Caucasian in ethnicity, with very small numbers from a few other ethnic groups. Most of the volunteers received partial credit toward psychology courses (an alternative assignment was also provided in these courses), while a few volunteered without receiving credit. Participants were treated in accordance with the "Ethical Principles of Psychologists and Code of Conduct" (American Psychological Association, 2002).

Procedures.

Participants were randomly assigned to one of three study conditions, and each was seen individually for a session averaging about 40 minutes in length. After the informed consent process, the participants were asked to write any thoughts that came into their minds for six minutes. The experimenter left the room during this period.

Experimental participants (the Suppress group) were instructed NOT to think about a white bear as they wrote. Naturally, this rather paradoxical instruction brings thoughts of a white bear immediately to mind, and then requires inhibition, thus drawing on self-regulatory capacity, according to previous research. If they **did** think about a white bear, they were told to put a check mark in the margin as they were writing. (This was designed to increase awareness of these thoughts and make inhibition even more difficult.)

One control group (the Express group) was instructed to think about a white bear as much as they could as they wrote, also putting a check mark in the margin when they did think of a white bear. A second control group received no additional instructions. In this way, the two control groups were also required to reflect on their thoughts and write them down, just as in the experimental condition. In the Express group, there was the additional requirement to think about a white bear, but this was expected to tax self-regulatory resources far less than inhibiting those thoughts would.

Subsequently, participants were given a list of very difficult[1] anagrams to try to solve, and again were left alone, with instructions to spend as much time as they wished working on the anagrams, and to ring a bell when they wished to quit. This task requires

1 In contrast to Muraven et al. (1998), we used anagrams that were very difficult, but solvable. This was done in order to ensure that participants were engaged in the task and maintained maximal persistence. With unsolvable anagrams, it was our view that some participants might be able to determine that they were unsolvable and would not persist for that reason.

sustained attention, the ability to visualize multiple arrangements of letters, verbal fluency, and maintaining effort in the face of failure (since the anagrams were very difficult). The time (in seconds) spent working on the anagrams was recorded. In this way, participants' persistence in the face of frustration would be our dependent measure of self-regulatory capacity.

Participants were then asked to respond to questions on a short debriefing form and a demographics form (as well as two self-report measures related to another aspect of our research, a 40-item measure of attention-deficit disorder symptoms and a 90-item measure of general psychological distress). Once these measures were completed, the participants were thanked and debriefed, and they had a chance to ask questions and make comments.

Results

It was predicted that participants who received a self-regulatory challenge (Suppress group) would spend less time working on the anagrams than the control groups. This prediction was not supported. A one-way analysis of variance revealed no statistically significant differences in anagram time among the three groups, $F(2,73) = .274$, $p = .761$. Standard deviations were large in all groups, showing great variability in the time participants worked on the anagrams (see Table 2).

To further explore our results, we examined the correlation between the number of thought intrusions (i.e., check marks in the margin, which we thought to be a measure of self-regulatory effort, with fewer intrusions suggesting greater effort) for the experimental group and persistence on anagrams; the correlation was not significant ($r = -.019$, $p = .929$). We also looked at the correlation between number of thought intrusions and number of anagrams solved (an alternative dependent measure of self-regulatory resources); this was non-significant as well ($r = .091$, $p = .666$).

General Discussion

Neither of the experiments reported here revealed evidence of depletion of self-regulatory resources. Our failure to replicate the findings of prior studies was unexpected, and is puzzling. The present research utilized strict protocols; participants were run individually, in carefully controlled sessions. Our experiments also involved larger participant samples than were reported in some earlier studies. Still, the findings are in opposition to what the strength model would predict, and this suggests a challenge to the adequacy of this model as a description and explanation of self-regulatory failure.

Alternative explanations for failure to find self-regulatory depletion

Large individual differences in self-regulation were the rule in our results, and these were not accounted for by any of the variables we measured. This variability may have partially obscured any patterns of depletion in self-regulatory capacity. Future research might avoid this problem by using a within-subjects design, subjecting the same participants to each condition (over a span of time), and examining relative depletion. Clearly, however, an important task for future research will be to continue to clarify factors that account for the substantial individual differences in self-regulation such as those described here and in the literature.

In addition, it is possible that our manipulation of self-regulation in Study 1 with the computerized Stroop task did not sufficiently tax participants' self-regulatory resources, contributing to our failure to find depletion. In the experimental group, we alternated tasks involving the color-word interference effect (the Stroop effect) with other tasks, which we thought would maintain interest and increase the overall challenge. Possibly, it may have been more effective to utilize more trials that directly involved the Stroop effect.

Also in Study 1, it was noted that participants were typically aware that the experimenter was timing them in the handgrip task and recording their time (in spite of our efforts to be subtle about this). Informal observations suggested that when the task was presented the second time, participants often seemed motivated to increase their handgrip-squeezing time. It was not unusual for participants to say things like, "I think I did better that time." This appeared to be a matter of importance to many participants, across condition. Also, motivation for these participants may have been relatively high because they were not part of a regular subject pool, and the opportunity to take part in research of this kind was somewhat novel. It is possible that there were also demand characteristics in the experimental context that had some influence here; perhaps participants played the role they thought was expected of them – in this case, squeezing the handgrip for a longer period the second time. Any, or all, of these factors may have produced effects that were larger than any depletion effect, masking it. On the other hand, it provides information about the relative importance of the various influences on self-regulation, when the size of any depletion effect seems to be small in comparison to other factors.

It might be useful for future research to utilize additional dependent measures that might clarify aspects of self-regulation; an interesting possibility is the Thayer scale (Thayer, 1978), a measure of subjective alertness that may be an indicator of available self-regulatory resources (Smit, Eling, & Coenen, 2004).

In Study 2, our use of anagrams that were solvable, but difficult, distinguished our study from that of Muraven and colleagues (1998), whose results we were attempting to replicate. Since our participants succeeded in solving very few of the anagrams, it does not appear that this explains our failure to replicate the original study. If this did have an effect on the results, the effect would most likely have been one of increasing participants' persistence on the anagrams across conditions. However, resource depletion was expected to have occurred in the experimental group, and this would, of necessity, flatten any increase in persistence in that group. The increase in persistence would be expected to be more evident in the control conditions, then, and this would enhance the gap between conditions, highlighting any depletion effect.

This, clearly, was not the case. Our groups' mean anagram times overall were somewhat lower than those obtained in the study by Muraven and colleagues (1998), and all of the groups' standard deviations were somewhat larger. Particularly large was the standard deviation of the experimental group (354 secs., as compared to 240 secs. in the Muraven study). It thus appears that large individual differences in this group may have masked any depletion effect in our study.

Gender considerations

An important limitation of the present study is the proportion of female to male participants; our samples were predominantly female, by a ratio of almost 9:1 (in both experiments combined, 130 females and 15 males). It is possible that this helps to account for the different findings here, compared to previous research. A review of some of the literature on gender and self-regulation may help us to interpret these findings.

According to Nolen-Hoeksema and Corte (2004), previous research has shown that there are some areas where gender differences in self-regulation strategies are clear. One is in the styles of coping with negative emotions. Studies suggest that women are more likely to take a passive stance toward negative emotions, ruminating about them; this is associated with higher rates of depression. On the other hand, men have been shown to be more likely to use, and abuse, alcohol.

In the self-regulation of health behaviors, important sex differences are evident in several ways. Gender was one of a number of factors contributing to the prediction of adherence to asthma treatment, with females more likely to adhere (Jessop & Rutter, 2003). In a study of patients' self-regulation in managing hypertension, some similarities, but significant sex differences, were noted; men's efforts were more closely related to perceived control and chance of success; women's efforts were more related to the expectations of significant others (Taylor, Bagozzi, & Gaither, 2001). With regard to self-regulation strategies used in recovering from illness in general, there were significant gender differences reported in the use of most of the strategies examined (Massey, 1991).

Mixed results have been found with regard to sex differences in other aspects of self-regulation. Sex is one of many factors associated with differences in the self-regulation of driving habits (Lesikar, 2000). Males report more risky driving behaviors and seem to be more present-oriented; females tend to be more future-oriented in this area (Zimbardo, Keough, & Boyd, 1997). However, in studies of athletes' use of self-regulation strategies in competitive swimming, there were few significant sex differences found. The marked differences that were found were between elite and non-elite athletes, and only minor strategy differences were sometimes evident between males and females (Anshel & Porter, 1996, 1996a).

In academic achievement, among children and adolescents, girls were found to have more confidence in their ability to self-regulate in learning tasks (although this was found to be associated more with the feminine gender role than with biological sex; Pajares & Valiante, 2002). In a study of self-regulated learning in high school students, girls were shown to have greater knowledge about the role of thinking in self-regulation of learning, to use more metacognitive and other strategies, to be more intrinsically motivated, and to express more feelings related to learning (Peklaj & Pecjak, 2002). In a similar study of self-regulation of learning among college freshmen, however, males and females were found to be more alike than they were different (Minnaert, 1999). Possibly, the differences found in younger individuals are developmental in nature and wash out in young adulthood. In the Minnaert study, one exception was a sex difference found in the tendency to avoid failure; for females, high fear of failure was linked to deficits in regulatory activities (Minnaert, 1999).

Kurman (2001) reviewed studies related to sex differences in achievement areas more generally. According to this review, there is evidence to suggest that women tend to have lower expectations of success in achievement areas, which influences goal-setting. Also, women may often prefer easier tasks, compared to men, although this may only apply to masculine-type tasks. In addition, Kurman reports that women respond differently to feedback (tending to perceive it as containing more information than men do, especially when it is negative, possibly because they are more oriented to others' opinions), and use different criteria in judging their own success. However, Kurman points out that many of these studies were conducted in Western universities, and that the results may not be reflective of people, especially women, everywhere. In Kurman's own cross-cultural study, cultural differences in self-regulation were greater than gender differences, and culture and gender interacted in some ways (Kurman, 2001).

There is also a body of literature addressing sex differences in anagram performance that might be relevant to the interpretation of our results from Study 2. First, we considered whetherfemales across condition might persist on anagrams longer than male participants might, due to greater skill with anagrams and similar tasks. There have been some conflicting results reported in the literature with regard to this issue. One review of the previous research concluded that females generally perform better on tests of word fluency (Mendelsohn & Covington, 1972). Also, school-aged girls were found to perform better than boys on an anagram task (Stevenson, Klein, Hale, & Miller, 1968). In two studies of adults, however, no sex differences in performance on word or nonsense anagrams were found (Mendelsohn & Covington, 1972; Travis, 1982).

Next, we considered whether females across condition might persist on anagrams longer than male participants would, due to different expectations of success with anagrams or similar tasks. Previous research does not support the idea that women have higher expectations of success, compared to men, on anagram tasks. In fact, college-aged women in one study had generally lower expectations for their performance on anagrams compared to men (Sleeper & Nigro, 1987). Other research reveals no sex differences in participants' expectancies of success on anagram tasks (McMahan, 1973; Travis, 1982).

We also entertained the possibility that females across condition might persist on anagrams for shorter periods, relative to male participants, due to different self-evaluations, attributions of success, or reactions to failure in solving the anagrams.

Based on two experiments using anagram tasks, male and female college students did not differ significantly in performance, but there were interesting differences; male participants perceived their performance and skills more positively, while females more often attributed success to luck (Deaux & Farris, 1977. These authors concluded that the greatest sex differences in self-evaluation and in self-attributions occur in response to failure, as well as on masculine tasks (Deaux & Farris, 1977).

On the other hand, based on studies of sex differences in the anagram performance of school-aged children by Miller (1985, 1986), male and female participants in the current study might be expected to have similar levels of persistence in working on the difficult anagrams we used, for different reasons. With males, persistence may have been impaired because failure on earlier items would be likely to pose an ego threat, interfering with performance on later items. (This assumes that the male participants thought of the task as being average or moderate in difficulty level, given the experimental context and instructions.) For females, persistence may have been impaired because of a learned helplessness effect – after the first few items, they would be likely to perceive effort as unrelated to success (Miller, 1985; Miller, 1986)

It appears, then, that there are similarities and differences in self-regulation associated with gender that emerge in many contexts; these differences are difficult to describe in terms of any one, neat pattern. Based on our review of the literature on sex differences in self-regulation in general, we might anticipate that our predominantly female participants would tend to have lower expectations of success and might tend to avoid failure by giving up on tasks (e.g., the anagrams) sooner, compared to males, possibly contributing to our failure to find a depletion effect.

There might also have been a task by gender interaction that masked a depletion effect. In study 1, females might be expected to see the handgrip task as masculine-typed, and therefore not exert as much effort. Males would probably see the activity as more related to their gender, and failure as more of a threat to their identity, so that they might tend to try harder on the handgrip. We can speculate as to the effect this gender difference might have on depletion of effort (the difference between pre- and post-Stroop handgrip efforts) for individuals. Possibly, if females exert little effort in the first handgrip task, this might lead to smaller pre-post differences, reducing the chance of seeing depletion after the manipulation of self-regulation.

With regard to study 2, it is not clear, based on our review of the literature, whether females would tend to have different levels of persistence on the anagram task, compared to males. Females do not appear to be better at anagram tasks, and may not have different expectations of success on them. Based on some of these studies, we might predict similar persistence on this difficult task across gender, although for different reasons. On the other hand, females' self-evaluations in the face of failure may be more negative, possibly leading them to give up sooner than males might on the anagrams.

If this tended to occur with our participants, we might well see a restricted range of anagram scores that might obscure group differences, and thus mask any depletion effect

It thus appears possible that our predominantly female participants might have reacted in several different ways that masked depletion effects. Future research might further investigate the possibility of gender differences in any depletion patterns. If there is a broad self-regulatory depletion effect, as described in previous research, does it work differently for men and women? Do some types of tasks function to manipulate and/or measure self-regulation for males more effectively than they do for females?

It should be noted that there are also many other variables involved when discussing sex differences in self-regulation; age, type of task, culture, gender role, and the individual's skill level may interact with sex, and often have unique contributions to self-regulation that are more influential than sex itself.

Conclusions

In our view, then, the nature of self-regulation and the mechanisms involved in self-regulatory failure remain somewhat unclear. We agree with Efklides and colleagues (2002), that there are still many questions that remain to be answered about self-regulation. As we have said, further research is needed to continue clarifying the variables that account for the substantial individual differences that have been seen in the performance of self-regulation tasks.

With regard to the depletion effect, it appears to us that individuals in everyday contexts, e.g., at work, experience self-regulatory demands over long periods of time, and they respond reasonably well to these demands, although perhaps experiencing some drop in effectiveness with the passage of time. It seems unlikely that demands presented over the course of an experimental session would tax resources that often endure for the course of a day, or longer.

As a possible alternative to, or addition to, the depletion explanation, we would like to suggest that self-regulatory failure may be due in part to difficulty in organizing and reorganizing cognitive resources. That is, perhaps participants seem depleted in previous studies because they are having difficulty switching from one domain (type of task) to another. It seems likely that some people are better than others at organizing their behavior to make these transitions (which would help to account for the large individual differences observed in our study). Also, people gain skill in coordinating cognitive resources and behaviors in familiar contexts, e.g., a job they have held for some time. The ability to "multi-task" develops as an individual gains experience and skill in the relevant areas. In contrast, participants in experiments are fish out of water – they may have difficulty adjusting to the novel context and its demands. This may be particularly true for the typical studies in self-regulatory depletion, which tend to cross domains (e.g., presenting a physical task, then an emotional control task). Self-regulatory failure in these studies may occur more because of difficulty organizing the required responses, rather than because of simple depletion of resources.

Based on informal observations of our participants, we would also like to propose that motivation might play an especially important role, perhaps a central one, in self-regulation. As described above, in Study 1, the conditions of the experiment were apparently such that our participants often explicitly tried to increase their handgrip time from pre- to post-test (often succeeding). Perhaps when motivation is high, depletion of resources does not occur, or is minimal. Possibly, it is only when motivation is at lower levels that depletion is most evident.

Future research might focus on clarifying operational definitions of self-regulation, and establishing more reliable means of assessing and manipulating this important psychological variable. It may be helpful to focus on particular aspects of self-regulation (e.g., impulse control), rather than attempting to study self-regulation in its broader sense. Greater specificity and more clarity in operational definitions may aid in the interpretation of discrepant findings such as these, and contribute to further progress in this line of research.

Self-regulation is clearly a complex phenomenon, not easily amenable to manipulation, and influenced by a number of state and trait factors. We would propose an important role for motivation, but we would also include sex and gender role, contextual factors, culture, fatigue, stress, and various temperament and personality traits (Efklides et al., 2002) in explaining self-regulation and its failures. In addition, it may be the case that self-regulation, and self-regulatory failure, are more domain-specific than previous research has suggested. It is hoped that the studies presented here will shed some new light on our current understandings of this key resource of the self.

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Table 1

Handgrip Time (in Seconds): Descriptive Statistics from Study 1

	Means		Standard deviations	
	Pre-task	Post-task	Pre-task	Post-task
Condition				
Control	74.33	70.33	92.02	55.89
Experimental	66.76	67.12	50.15	42.13

Table 2

Anagram Time (in Seconds): Descriptive Statistics from Study 2

	Means	Standard deviations
Condition		
Express (control)	574.12	300.53
No additional instructions (control)	633.68	302.82
Supress (experimental)	628.88	354.42

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