



## Erratum to “Motivation, personal beliefs, and limited resources all contribute to self-control”<sup>☆</sup>

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### ABSTRACT

What effects do motivation and beliefs have on self-control? We tested this question using a limited resource paradigm, which generally has found that people show poor self-control after prior exertions of self-control. Recent findings have suggested that motivation and even belief in unlimited willpower can render persons immune to ego depletion. We replicated those findings, but also showed they are limited to cases of mild depletion. When depletion is extensive, the effects of motivation and subjective belief vanished and in one case reversed. After performing only one self-control task, the typical pattern of self-regulation impairment was ameliorated among people who were encouraged to regard willpower as unlimited (Experiment 1) or motivated by task importance (Experiment 2). Those manipulations failed to improve performance among severely depleted persons who had done multiple self-control tasks. These findings integrate ideas of limited resources, motivation, and beliefs in understanding the nature of self-control over time.

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Is self-control a matter of managing a limited energy supply or does it depend more on subjective beliefs and motivations? The purpose of the present research was to assess the contributions of motivation, mindsets, and limited resources in self-control. One current model says that self-control is best understood as a limited resource that becomes drained with use. In support of this model, studies have shown that after people exert self-control, they perform worse on other self-regulatory tasks (Baumeister, Vohs, & Tice, 2007; Hagger, Wood, Stiff, & Chatzisarantis, 2010; Vohs & Heatherton, 2000).

Other research suggests self-control might be caused more by beliefs, motivation, or mindsets than limited resources. For instance, Schmeichel and Vohs (2009) found that pondering personal values offset the negative effects of depletion. Denson, Jacobson, von Hippel, Kemp, and Mak (2012) found that believing that one has ingested caffeine reduces aggressive responding after depletion. Muraven and Slessareva (2003) showed that offering incentives can overcome depletion, which some have taken to suggest that depletion is not an energy deficit but simply a lack of motivation. Job, Dweck, and Walton (2010) measured and manipulated beliefs, and showed that people who believed in unlimited willpower

were immune to ego depletion. They provocatively proposed that ego depletion is “all in your head,” in effect being a self-fulfilling prophecy due to the possibly mistaken belief that willpower is limited.

The present research addressed the question of motivation and personal beliefs by integrating the findings of Job et al. (2010) and Muraven and Slessareva (2003) with the broader set of ego depletion findings. Our goal was to build on the findings and insights from those works in order to create a broader understanding of self-regulation. More precisely, we hypothesized that personal beliefs and motivations can have substantial and significant effects on self-regulation under conditions of incipient or moderate depletion, but that such effects falter as the reduction of limited resources progresses to more profound levels. Thus, beliefs and motivations play an important role, but they are not the whole story.

Prior work has found that the effects of mild levels of ego depletion are susceptible to influence by attitudes and beliefs. Moller, Deci, and Ryan (2006) showed that making a few aversive, externally constrained choices caused ego depletion, but no such effect was found from making a few pleasant, autonomous choices. Vohs et al. (2008) replicated their findings but also showed that when many decisions had to be made, depletion was observed regardless of whether people enjoyed or disliked the process. Applying similar logic, we reasoned that manipulations of motivation and beliefs might well moderate the effects of mild levels of ego depletion but would have less impact when depletion was severe.

The broader implication would be that ego depletion is a real, potentially powerful condition, but that at mild and moderate levels its

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impact competes with other variables such as subjective beliefs and motivations. Relatively low levels of ego depletion would have relatively small effects, and these could be washed out or reversed by other variables. However, as the extent of energy depletion increases, the scope for influence by other variables would diminish. By analogy, a slightly tired person might perform at a high level when bolstered by subjective motivation or self-confidence – but severe exhaustion would take its toll regardless of such factors.

Ego depletion has been shown to involve self-regulation and self-control (Hagger et al., 2010; Richeson & Shelton, 2003), choice and decisions (Vohs et al., 2008), and rational thinking (Schmeichel, Vohs, & Baumeister, 2003). The procedures for the present studies used all three of these, to increase generality and reduce implicit demand characteristics. Our focus was on the availability of willpower for all tasks, rather than focused specifically on self-control.

## Experiment 1

**Experiment 1** followed Job et al. (2010) and manipulated belief in limited versus unlimited willpower. Extent of depletion was manipulated by having participants do zero, two, or four depleting tasks prior to the dependent measure. The prediction was that belief in unlimited willpower would counteract ego depletion (reflected in better performance on the dependent measure) when participants had simply done two tasks – but not when they had done four tasks.

### Method

#### Participants

Eighty-three undergraduates (44 female) participated in exchange for extra course credit. Data from five participants were excluded because they failed to pay adequate attention to the tasks: Four participants' were found playing with their cell phones and one fell asleep. Participants were randomly assigned among six conditions in a  $2 \times 3$  design.

#### Procedure

Participants came to the laboratory individually for a study on goals. The first task comprised the manipulation of willpower beliefs and consisted of having participants rate their agreement with biased questionnaire items (Job et al., 2010). One version of the questionnaire promoted belief in unlimited willpower with items such as "Sometimes, it can be very inspiring to think over a matter with great concentration." The other version promoted belief in limited willpower, using items such as "When you think over a matter with great concentration, it can be sometimes tiring." The eight items had high internal reliability ( $\alpha=.90$  and  $\alpha=.83$  for the limited and unlimited versions).

Next came the depletion manipulation. In the zero-task (no depletion control) condition, participants viewed products on a computer screen for 4 min and wrote phrases or words that occurred to them. They were told that in the end, they would receive one of the products they viewed. That was all. In the two-task condition, participants viewed the same products as in the zero-task condition but made choices from pairs of them for 4 min. They had been told their choices were real and binding: They would receive one of the options they had selected. (And they did.) Making such choices has been shown to cause ego depletion (Vohs et al., 2008). They also performed the Stroop task on the computer for 2 min, during which they had to type the first letter of the font's color, with the screen displaying the name of a color different from the font in which it appeared.

In the four-task (severe depletion) condition, participants first completed the choice and Stroop tasks as in the two-task condition. Next, they watched an excerpt from a comedy video (Eddie Murphy Raw; Townsend, 1987) under instructions to stifle their facial and emotional reactions (Gross, 1998; Schmeichel et al., 2003). Last,

they were given two pages of text and instructions on when to cross out appearances of the letter *e*. Following Baumeister, Bratslavsky, Muraven, and Tice (1998), they crossed out all *e*s on the first page, thereby acquiring the habit of crossing out every instance of the letter *e*; but for the second page they were instructed to cross out every *e* except in cases where a vowel appeared immediately after or two letters prior to the *e*. This required them to override the habit and refrain from crossing out all of the *e*s.

To summarize, this experiment used three conditions that varied in the demandingness of the self-control tasks. Some participants used virtually no self-control (zero-task condition), whereas others used a moderate amount (two-task condition) or used quite a bit (four-task condition) of self-control to perform their initial tasks. The conditions therefore differed in self-control energy, time, and task difficulty.

As dependent measures of self-control ability, all participants completed two measures. The first assessed preferences for delayed versus smaller but immediate rewards. Delay of gratification has been a powerful exemplar of self-control (Loewenstein, Read, & Baumeister, 2003; Mischel, Ebbesen, & Zeiss, 1972). Participants made six intertemporal choices regarding monetary preferences. These started with the choice between \$10 now and \$11 a week hence, with each successive item progressively increasing the latter amount by \$1, ending with the choice of \$10 now versus \$15 in a week (Green, Fristoe, & Myerson, 1994). No legal investment options guarantee a 10% return in a week, so economic rationality would dictate choosing the delayed option on all but the first trial. Hence the measure of self-control consisted of the number of times the participant favored larger delayed over immediate but smaller rewards.

The second measure was the Cognitive Estimation Test (CET; Bullard et al., 2004), comprised of 20 questions that require active, logical thinking and extrapolation in order to generate plausible estimates for unknown quantities (e.g., How much do a dozen, medium-sized apples weigh?; Shallice & Evans, 1978). The CET comes with scoring norms. Two points were given for answers that were between the 25th and 75th percentile of the response range. Responses outside the 90% range were given 0 points, and the (intermediate) rest received 1 point. Thus, high scores indicate better performance. CET scores have been used as a measure of self-control by Schmeichel et al. (2003), who found that decision makers' ability to form reasonable answers to somewhat nebulous questions relied on self-regulatory resources.

### Results and discussion

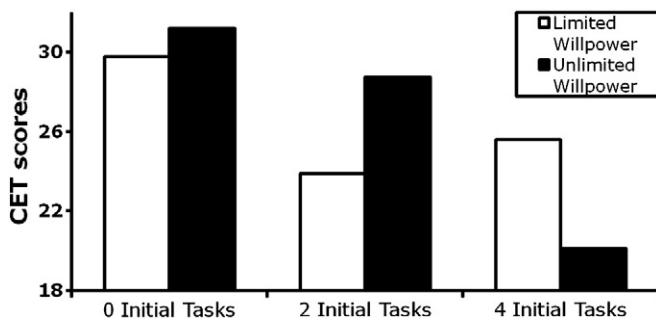
#### Manipulation check

Following Job et al. (2010), we calculated a manipulation check by comparing the mean in each condition against the scale midpoint of 3.5. A one-sample *t*-test found that both willpower theory conditions endorsed the scale items more than the midpoint: limited ( $M=2.11$ ,  $SD=.58$ ,  $t(77)=15.32$ ,  $p<.001$ ); unlimited ( $M=2.31$ ,  $SD=.57$ ,  $t(77)=12.65$ ,  $p<.001$ ). Thus, participants agreed with the theory of willpower that was consistent with the bias in their questionnaire.

#### Self-control

Both measures of self-control were analyzed using a  $2 \times 3$  analysis of variance (ANOVA) with willpower theory (limited versus unlimited) and self-control tasks (0, 2, or 4) as between-subject factors. CET scores were predicted by the interaction of willpower and self-control task conditions,  $F(2, 72)=4.65$ ,  $p<.02$ . The main effect of self-control depletion condition was also significant,  $F(1, 72)=9.91$ ,  $p<.01$ . The main effect of willpower theory was negligible,  $F<1$  (Fig. 1).

Planned comparisons elucidated the interaction. In the zero-task (no depletion) condition, willpower belief did not alter performance on the CET,  $t(72)<1$ . In the two-task condition, participants who had been induced to believe in unlimited willpower outperformed



**Fig. 1.** Effect of willpower theory and self-control task conditions on CET scores, Experiment 1.

those induced to regard willpower as limited,  $t(72)=2.04$ ,  $p<.05$ . Both these findings replicate those of Job et al. (2010) and uphold the validity of their contribution.

In the four-task (severe depletion) condition, however, the effect of belief was reversed. Participants who had been induced to regard willpower as unlimited performed significantly worse than those who had been led to consider it limited,  $t(72)=2.21$ ,  $p<.05$ .

Similar patterns were found on our other measure of preference for delayed rewards. The interaction of willpower theory condition and depletion extent was significant,  $F(1, 72)=4.29$ ,  $p<.05$ , as was the main effect of self-control condition,  $F(1, 72)=9.47$ ,  $p<.01$ . The main effect of willpower theory condition was not significant,  $F<1.32$ .

Planned comparisons revealed that delay of gratification was unaltered by willpower theory condition if participants had performed no initial self-control tasks,  $t<1$ , ns. Under mild depletion (two self-control tasks), participants chose delayed rewards significantly more when they regarded willpower as unlimited rather than limited,  $t(72)=3.08$ ,  $p<.05$ , which is a conceptual replication of Job et al. (2010). Thus, belief in unlimited willpower contributed to behavior consistent with rational, enlightened self-interest. However, the effect of personal willpower belief disappeared among the severely depleted (four-task) participants,  $t<1$ ; Fig. 2.

Thus, we replicated the provocative findings of Job et al. (2010): Belief in unlimited willpower ameliorated the impact of ego depletion—but only under mild depletion. Our novel finding, internally replicated with two measures, was that the effects of personal beliefs were wiped out and in one case reversed among severely depleted persons. This suggests that personal beliefs can have a substantial, beneficial effect when depletion is mild. But with increasing levels of depletion, personal theories lose their power to override the loss of energy.

If anything, we saw evidence that people's performance can worsen when believing that the mind contains unlimited self-control capacities, and hence that personal beliefs can be counterproductive. It

could be that there was a contrast between what participants expected to be capable of doing (e.g., any task requiring self-control) and self-perceptions of performance (e.g., I am not performing the task with ease), similar to work on reversals of expectancy effects on behavior. Or believing that willpower is unlimited might undermine the normal tendency to conserve resources (Muraven, Shmueli, & Burkley, 2006) so that people find themselves severely depleted after multiple tasks.

## Experiment 2

**Experiment 2** sought to show that subjective motivation could overcome the effects of mild but not severe depletion. By analogy to physical strength, we hypothesized that a slightly tired person can perform at a high level when sufficiently motivated, but that as exhaustion progresses, the capacity to rise above it based on subjective motivation would dwindle.

### Method

#### Participants

Two hundred fourteen (115 female) undergraduates participated for extra course credit. They were randomly assigned among six conditions in a  $2 \times 3$  design. Unusable data from five participants were discarded, chiefly because they talked on cell phones or napped rather than engaging fully with the experiment.

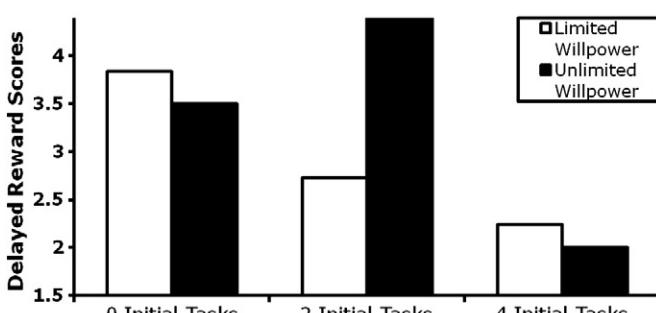
#### Procedure

Participants came to the laboratory individually and were told the session consisted of several unrelated experiments. Instructions in the *high motivation* condition were modeled on those of Muraven and Slessareva (2003). In that work, high motivation was induced by telling participants that the research of which they were a part could have a significant influence on science's understanding of mental diseases. Likewise, we attempted to induce a state of increased motivation by telling our high motivation condition participants that the current research was part of an initiative in the marketing department called "The Science Behind Better Lives," which would aid consumer welfare, happiness, and health. Participants in the *neutral motivation condition* were not told anything about the special importance of the study.

Three levels of depletion were manipulated. Participants in the *zero-task* and *one-task* conditions were first given the e crossing task as in **Experiment 1**: The zero-task participants did only the simple version, while the one-task participants did the simple version followed by the more demanding version (which required self-regulation to override the learned response).

Participants in the *three-task condition* first performed a task that was presented as a media perception task. They watched a disturbing clip from the movie *Mondo Cane* (Jacopetti, 1961), showing the tragic effects of nuclear waste on animals and plants. To induce depletion, they were told to suppress all expressions and feelings of emotion (Vohs, Baumeister, & Ciarocco, 2005). Next, these participants made a series of choices. For 8 min, they perused images of consumer products, presented as binary choices (e.g., a yellow t-shirt versus a red t-shirt), and selected one. (They were told they would receive one of their chosen items, and they did.) Last, they performed the difficult e-crossing task, as in the one-task (mild depletion) condition.

The same two dependent measures as in **Experiment 1** were used, namely preference for delayed gratification and cognitive performance on the CET. Last, participants rated their degree of motivation and effort exerted during the experiment, as a manipulation check of the motivation condition (1 = *not at all*; 7 = *very much*).



**Fig. 2.** Effect of willpower theory and self-control task conditions on preferences for delayed rewards, Experiment 1.

## Results

### Manipulation check

The two items of motivation and effort exerted were summed ( $\alpha = .72$ ) to create an index of motivation. A  $2 \times 3$  ANOVA with motivation condition and extent of depletion as between-subject factors showed the predicted main effect of motivation condition,  $F(2, 203) = 21.01, p < .01$ . Participants in the motivation ("Better Lives") condition,  $M = 8.77, SD = 3.14$ , reported having more motivation than participants in the neutral motivation condition,  $M = 6.85, SD = 2.67$ . The main effect of self-control task condition and the interaction term were not significant, both  $Fs < 1$ . Thus, participants (even depleted ones) were motivated by the idea that their performance could help consumers live happier and healthier lives.

### Self-control

A  $2 \times 3$  ANOVA on CET scores yielded a significant interaction between motivation and depletion conditions,  $F(2, 203) = 3.03, p = .05$ . The main effect of self-control task condition was also significant,  $F(2, 203) = 23.09, p < .001$ , but the main effect of motivation was not,  $F(2, 203) = 1.72$  (Fig. 3).

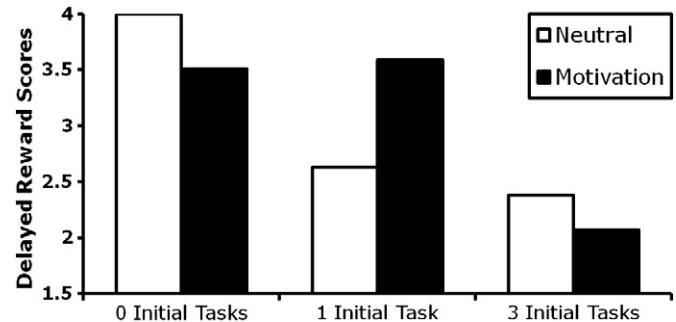
Pairwise comparisons illuminated the interaction. When participants had not exerted self-control initially, motivation had no effect on their CET performance,  $t(203) < 1$ . With mild depletion, high motivation significantly enhanced performance,  $t(203) = 2.82, p < .01$  (Fig. 3). These effects conceptually replicate those of Muraven and Slessareva (2003). Under severe depletion (four-task condition), however, motivation had no effect,  $t(203) < 1.05$ .

The findings on the delay of gratification measure followed a similar pattern. A  $2 \times 3$  ANOVA yielded an interaction between motivation and self-control,  $F(2, 201) = 3.07, p < .05$ . The main effect of self-control task condition was significant,  $F(2, 201) = 9.20, p < .01$ , whereas the effect of motivation condition was not,  $F < 1$  (Fig. 4).

Planned contrasts revealed that the effects of motivation were only significant when participants had performed one initial self-control task,  $t(201) = 2.32, p < .03$ . When participants had performed zero or three initial self-control tasks, there was no effect of motivation on preference for delayed rewards,  $t < 1$ . Participants in the mild depletion condition were less likely than non-depleted participants to make the rational choice for larger but delayed rewards,  $t(201) = 2.86, p < .01$ . The last finding replicates the usual effect of ego depletion.

## General discussion

Two experiments investigated the roles of motivation, personal beliefs, and finite volitional resources in predicting self-regulation over time. Our findings upheld the validity of both ego depletion theory and the recent contributions suggesting that it can be moderated by subjective belief (Job et al., 2010) and motivation (Muraven & Slessareva, 2003). We replicated findings showing that at mild levels of ego depletion, performance can be significantly improved, insofar as people



**Fig. 4.** Effect of motivation and self-control task conditions on preferences for delayed rewards, Experiment 2.

embrace personal theories of unlimited willpower (Experiment 1) and insofar as they are strongly motivated by incentives to perform well (Experiment 2).

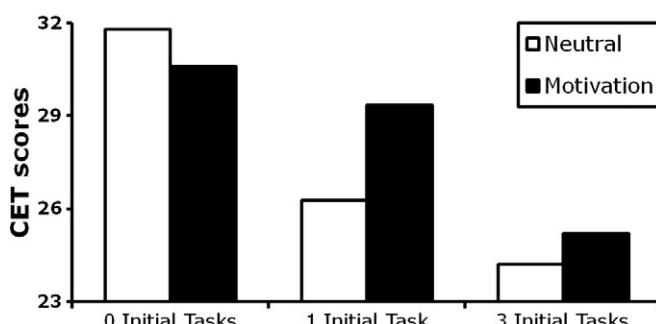
The bold claim that ego depletion is "all in your head" (Job et al., 2010) however should be tempered with the recognition that subjective beliefs and motivations are most efficacious when depletion is mild or incipient. Subjective beliefs in unlimited willpower did in fact improve performance among the slightly depleted. Among the severely depleted, however, those beliefs had no effect – if anything, they had the opposite effect.

Likewise, the effects of ego depletion were nullified when participants were motivated to perform well by a cover story extolling the high societal value of good performance – but only for mild depletion. Under severe depletion, motivational instructions yielded no benefit.

In our view, these findings parallel the effects with physical fatigue: Beliefs and motivations can sustain performance when fatigue is mild, but not so much when fatigue is severe. Thus, our findings suggest that human performance at self-control reflects an interaction between subjective, psychological factors and physiologically based energy states. Acts of self-control and decision making do in fact deplete some energy resource. When the depletion is slight, there is ample and profound room for subjective beliefs and motivations to moderate the effects. People who regard willpower as unlimited, and people who are motivated by strong values, can perform well despite having expended some of their resources in prior tasks. Likewise, psychological adaption processes might enable some performers to sustain performance during highly demanding regulation tasks (Converse & DeShon, 2009).

According to our findings, the impact of subjective factors diminishes as ego depletion increases and energy diminishes (just as with physical fatigue). No person can continue running or swimming forever, no matter how much he or she may be motivated. Likewise, the expenditure of willpower eventually becomes insurmountable. In retrospect, the view that believing in unlimited willpower can genuinely cause unlimited willpower is dubious. After all, if such beliefs could produce that effect, almost all world cultures would by now have embraced the doctrine that willpower is unlimited, because such beliefs would have boosted performance among their members. Cultures holding such beliefs would generally have outperformed cultures that subscribed to beliefs in limited willpower. Hence the belief in unlimited willpower would be normative worldwide, and effects of ego depletion would be scarce or nonexistent (cf. Hagger et al., 2010).

In sum, we propose that by integrating the contributions of Job et al. (2010) and Muraven and Slessareva (2003) with the bulk of research on ego depletion (Hagger et al., 2010), it is possible to move toward a deeper understanding of human agency. Ego depletion is a genuine state, accompanied by physiological changes (Gailliot et al., 2007; Inzlicht & Gutsell, 2007). Willpower may not be objectively unlimited, but subjective beliefs that it is unlimited and the desire



**Fig. 3.** Effect of motivation and self-control task conditions on CET scores, Experiment 2.

to do good deeds may improve self-regulatory performance among people who have already depleted their resources – up to a point. Eventually, the cumulative effects of resource depletion take their toll. When that happens, the impact of psychological states such as beliefs and motivating values is diminished.

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