



**Ego-depletion – Is it all in your head?
Implicit theories about willpower affect self-regulation**

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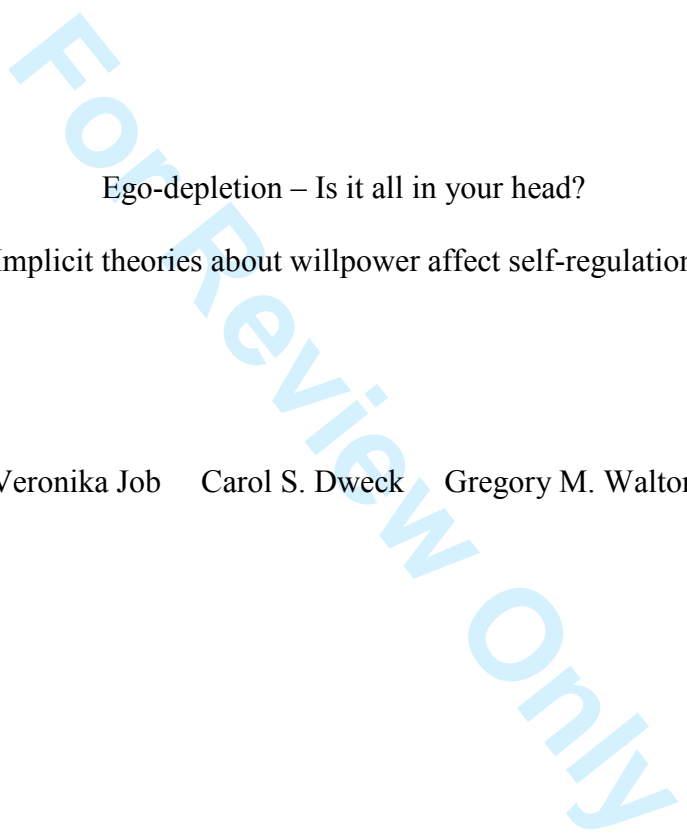
RUNNING HEAD: EGO-DEPLETION—IS IT ALL IN YOUR HEAD?

Ego-depletion – Is it all in your head?

Implicit theories about willpower affect self-regulation

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Abstract

Much recent research suggests that willpower—the capacity to exert self-control—is a limited resource that is depleted after exertion. We propose that whether depletion takes place or not depends on a person’s belief about whether willpower is a limited resource. Study 1 found that individual differences in lay theories about willpower moderate ego-depletion effects: People who viewed the capacity for self-control as *not* limited showed enhanced rather than diminished self-control after a depleting experience. Study 2 replicated the effect manipulating lay theories about willpower. Study 3 addressed questions of mechanism. Study 4, a longitudinal field study, found that theories about willpower predict change in eating behavior, procrastination, and self-regulated goal-striving in depleting circumstances. Taken together, the findings suggest that reduced self-control after a depleting task or during demanding periods may reflect people’s beliefs about the availability of willpower rather than true resource depletion.

Ego-Depletion—Is it all in your head? Implicit theories about willpower affect self-regulation

Some of the most provocative and influential research of the past decade has been conducted by Baumeister and colleagues, who have proposed and tested the *strength model of self-control* (e.g., Baumeister, Bratlavsky, Muraven, & Tice, 1998; Baumeister, Vohs, & Tice, 2007). This model suggests that acts of self-regulation consume a resource that is limited, leaving people in a state of *ego-depletion* and making them less able to exert self-control on a subsequent task. The strength model of self-control has inspired considerable research and accounts for an impressive array of empirical findings, including depletion effects on information processing (Fischer, Greitemeyer, & Frey, 2008), intellectual performance (Schmeichel, Vohs, & Baumeister, 2003), impression management (Vohs, Baumeister, & Ciarocco, 2005), and violent responses to partner provocation (Finkel, DeWall, Slotter, Oaten, & Foshee, 2009).

Some research, however, suggests that the exertion of self-control does not invariably reduce the capacity for subsequent self-control (e.g., Moller, Deci, & Ryan, 2006; Tice, Baumeister, Shmueli, & Muraven, 2007). For instance, people who are motivated to control themselves because of incentives may not show ego-depletion effects (Muraven & Slessareva, 2003). Most relevant to the present research, *expectancies* about diminished self-control following exertion can moderate ego-depletion effects. In one study, some participants were told that performing an effortful task (controlling their emotions) could improve performance on a subsequent task (Martijn, Tenbült, Merckelbach, Dreezens, & de Vries, 2002). These participants showed no decrease in performance on the subsequent self-control task (squeezing a hand-grip).

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3 Here we ask a more general question. Does holding a *global theory* that difficult tasks
4 are energizing rather than depleting prevent ego-depletion and help people sustain self-
5 regulation? Specifically, we test whether people's implicit theories about self-control moderate
6 ego-depletion effects. Much research documents the effects of implicit theories on self-related
7 processes. These implicit theories include beliefs about the nature of human attributes, such as
8 whether intelligence and personality are fixed or malleable (Dweck, 1999; Molden & Dweck,
9 2006; Blackwell, Trzesniewski, & Dweck, 2007). In the context of self-regulation, we propose
10 that people differ in their implicit theories about the availability and depletability of self-control
11 resources (or their "willpower"). Some people may think self-control is a limited resource, as
12 described in the strength model of self-control. Others may believe that self-control is not limited
13 and perhaps even that engaging in a strenuous task can activate self-control resources. We call
14 these the *limited resource theory* and the *nonlimited resource theory*, respectively. We suggest
15 that these theories affect how well people self-regulate when demands on self-control
16 accumulate.

36 *Overview of Studies*

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38 Three experiments and a longitudinal study tested the effect of implicit theories about
39 willpower on ego-depletion. The first studies, using a traditional ego-depletion paradigm,
40 measured (Study 1) and manipulated (Study 2) implicit theories to test the hypothesis that
41 implicit theories moderate ego-depletion. Study 3 examined mechanisms involved in the findings
42 from Study 1 and 2. For example, one possibility based on the strength model of self-control is
43 that people given a nonlimited resource theory perform well on a post-depletion task because
44 they "overuse" their resources while those given a limited resource theory conserve and
45 replenish their resources (Baumeister & Vohs, 2007). If so, on a third demanding task, people
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3 given the limited resource theory should perform better (Muraven, Shmueli, & Burkley, 2006).
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5 Study 3 also tested whether, following a demanding task, people with the nonlimited theory felt
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7 less exhausted than those with the limited theory or if they experienced the same level of
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9 exhaustion but were less affected by exhaustion. Finally, Study 4 examined the effect of implicit
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11 theories on self-regulation during a time of high self-regulatory demands (i.e., during students'
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13 final exams).
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16 17 18 Study 1

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20 Study 1 investigated whether individual differences in implicit theories about willpower
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22 moderate ego-depletion.
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24 25 *Method*

26 27 *Participants*

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29 Sixty students (42 females) participated in a “study on stimulus detection and cognitive
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31 processing” in exchange for course credit or \$10.
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34 35 *Materials and Procedure*

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37 First, participants completed a 6-item measure assessing implicit theories about
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39 willpower, specifically their theories about the effects of mental exertion. So as not to arouse
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41 suspicion, the measure was embedded in a questionnaire containing several implicit theory
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43 measures (e.g., of personality, of intelligence). Items included “After a strenuous mental activity
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45 your energy is depleted and you must rest to get it refueled again” (limited) and “Your mental
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47 stamina fuels itself; even after strenuous mental exertion you can continue doing more of it”
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49 (nonlimited) (*1=strongly agree, 6=strongly disagree*). Table S1, available on-line, presents the
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51 full scale. Items referring to the limited resource theory were reverse-scored so that higher values
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3 represent greater agreement with the limited resource theory. The scale was reliable ($\alpha=.89$) so
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5 the items were averaged ($M=4.13$, $SD=.84$).
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8 Participants then completed a “stimulus detection task.” This task was adopted from
9
10 previous research to manipulate ego-depletion (Baumeister et al., 1998; Tice, Baumeister,
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12 Shmueli, & Muraven, 2007; Wheeler, Briñol, & Hermann, 2007). It consisted of two parts, each
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14 lasting 5 minutes. First, all participants were instructed to cross out each “e” on a page of
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16 typewritten text. This task is designed to establish a behavioral pattern. Second, some
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18 participants were again instructed to cross out every “e” on a second page. Others, in the
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20 depleting condition, were asked to follow complex rules that sometimes required them to inhibit
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22 the previously established behavioral response (e.g., not to cross out “e’s” followed by vowels).
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27 Next participants completed a standard measure of ego-depletion—a Stroop task (Gailliot
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29 et al., 2007; Inzlicht, McKay, & Aronson, 2006; Webb & Sheeren, 2001). Color words appeared
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31 on a computer screen (*red, green yellow, blue*) in a font color that was either congruent or
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33 incongruent with the meaning of the word. Participants completed 48 trials (24 incongruent). In
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35 each, they were instructed to press a key marked with the color the word was written in. The
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37 Stroop task is a widely used measure of self-control because, on incongruent trials, the meaning
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39 of the word interferes with naming its color and has to be suppressed for accurate identification
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41 of the font-color. Previous research reports ego-depletion effects on performance on incongruent
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43 trials and not on congruent trials of the Stroop task (Inzlicht & Gutsell, 2007). Therefore, the
44
45 primary outcome was accuracy in response to incongruent trials.
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50 *Results and Discussion*

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52 Accuracy on each of the 24 incongruent Stroop trials was coded (correct=0, incorrect=1).
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54 We then fit a logistic curve for each participant using a Logistic Hierarchical Linear Model.
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3 HLM allowed us to control for covariates at the level of trials, and thus provides more precise
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5 estimates of participants' latent probability of responding accurately to incongruent trials than
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7 would ANOVA or regression. In all of our studies participants were more accurate when they
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9 took longer to respond and they became more accurate over more trials. To control for
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11 extraneous variation caused by speed-accuracy tradeoffs and order effects we included the two
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13 variables as trial-level predictors in each model.
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17 Participant-level predictors were ego-depletion condition (non-depleting=0, depleting=1),
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19 implicit theories about willpower (centered), and their interaction term.¹ There was a main effect
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21 of ego-depletion condition, $\beta=.36$, *odds ratio*=1.44, $t(1433)=6.71$, $p<.01$. Participants were more
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23 likely to make mistakes on the Stroop task after the depleting task than after the non-depleting
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25 task, replicating past research on ego-depletion. However, consistent with our predictions, this
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27 main effect was qualified by an interaction with implicit theories, $\beta=.28$, *odds ratio*=1.32,
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29 $t(1433)=3.88$, $p<.01$. As displayed in Figure 1, only participants with a limited resource theory (1
30
31 SD above the mean) showed the usual ego-depletion pattern, making more mistakes after the
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33 depleting task. Participants with a nonlimited resource theory (1 SD below the mean) showed no
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35 difference between the depleting and non-depleting condition.
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41 To analyze the interaction, we conducted separate HLM models for participants with a
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43 limited and a nonlimited resource theory.² These analyses confirmed that the difference between
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45 the depleting and the non-depleting condition was significant for participants with a limited
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47 resource theory, $\beta=.63$, *odds ratio*=1.88, $t(739)=8.27$, $p<.01$, and nonsignificant for participants
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49 with a nonlimited resource theory, $\beta=.04$, *odds ratio*=1.04, $t<1$.
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3 The results support the hypothesis that implicit theories about willpower moderate ego-
4 depletion. Only participants with a limited resource theory showed ego-depletion. Participants
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6 with a nonlimited resource theory showed no difference between the two conditions.³
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10 Study 2

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12 In Study 2, we manipulated implicit theories about willpower to test its causal effect in
13 moderating ego-depletion.
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15 Method

16 *Participants*

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18 Forty-six students (27 females) took part in exchange for course credit or \$10.
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20 *Materials and Procedure*

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22 First, we manipulated implicit theories about willpower. Participants completed a biased
23 questionnaire containing 9 items formulated to foster agreement with either a limited resource
24 theory (e.g., “Working on a strenuous mental task can make you feel tired such that you need a
25 break before accomplishing a new task.”) or a nonlimited resource theory (e.g., “Sometimes,
26 working on a strenuous mental task can make you feel energized for further challenging
27 activities.”) (1=*strongly agree*, 6=*strongly disagree*) ($\alpha=.84$). One-sample t-tests comparing the
28 mean in each condition to the scale midpoint (3.50) indicated that participants agreed with the
29 suggested theory in both the limited resource theory condition ($M=2.27$, $SD=.69$), $t(23)=-8.74$,
30 $p<.01$, and the nonlimited resource theory condition ($M=2.80$, $SD=.68$), $t(21)=-4.78$, $p<.01$.
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48 The rest of the study was identical to Study 1. Participants completed a “stimulus
49 detection task” containing the ego-depletion manipulation and then the Stroop task.
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51 *Results and Discussion*

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3 We ran a Logistic HLM model with accuracy of responses on incongruent Stroop trials as
4 the dependent variable (correct=0, false=1), again controlling for reaction time and order.
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6 Predictor variables were ego-depletion condition (non-depleting=0, depleting=1), implicit theory
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8 condition (nonlimited theory=0, limited theory=1), and their interaction. As predicted, the
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10 interaction was significant, $\beta=1.15$, *odds ratio*=3.17, $t(1097)=8.47$, $p<.01$. As displayed in
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12 Figure 2, only participants led to adopt the limited resource theory showed ego-depletion,
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14 making more mistakes after the depleting task than after the non-depleting task. The opposite
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16 pattern emerged for participants in the nonlimited resource theory condition. Separate analyses
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18 of the two theory groups confirmed that the difference between the depleting and non-depleting
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20 conditions was significant (though in opposite directions) in both the limited resource theory
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22 condition, $\beta=.72$, *odds ratio*=2.06, $t(571)=10.53$, $p<.01$, and the nonlimited resource theory
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24 condition, $\beta=-.42$, *odds ratio*=.66, $t(523)=-4.35$, $p<.01$.
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32 The results show that manipulated theories about willpower as either a limited or
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34 nonlimited resource moderate ego-depletion, confirming that the moderating role of implicit
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36 theories about willpower is causal. Interestingly, participants who were induced to hold a
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38 nonlimited resource theory performed worse after the non-depleting task than after the depleting
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40 task. It is intriguing to speculate that they were “depleted” by boredom rather than self-control,
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42 though this effect needs to be replicated in future research.
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46 Study 3

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48 Study 3 was designed to replicate the findings of Study 2 and to shed light on possible
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50 mechanisms. First, we tested whether participants with a nonlimited resource theory “overuse”
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52 their resources on the task following the depletion manipulation, leaving them depleted for a
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54 third task (see Muraven et al., 2006). Therefore, Study 3 assessed performance on two successive
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3 tasks after the depletion manipulation—Stroop performance and IQ performance. Second, we
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5 examined participants' subjective experience of exhaustion. We tested (1) whether implicit
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7 theories about willpower changed the degree to which the initial task demanding of self-control
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9 was experienced as exhausting and (2) whether implicit theories changed the degree to which the
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11 subjective experience of the task as exhausting undermined subsequent performance.
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14 15 *Method*

16 17 *Participants*

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19 Seventy-seven students (53 females) took part in exchange for course credit or \$10.
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22 23 *Procedure*

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25 Participants were randomly assigned to complete one of the two versions of the biased
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27 questionnaire used in Study 2. Next they completed the e-crossing task containing the depletion
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29 manipulation. The e-crossing task was followed by a question assessing subjective exhaustion,
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31 “How exhausting was the stimulus detection task for you?” (1=*not at all*, 9=*very much*).
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35 Participants then completed the Stroop task. Finally, they were given 8 challenging IQ
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37 problems, as previous research shows that intellectual performance is particularly sensitive to
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39 ego-depletion (Schmeichel et al., 2003). Participants were asked to select which of 5 figures best
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41 fit in a series of figures. They had 20 seconds to solve each problem.⁴
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44 45 *Results and Discussion*

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47 We ran the same Logistic HLM model described in Study 2 on Stroop performance. The
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49 interaction between theory condition and depletion condition was significant, $\beta=.25$, *odds*
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51 *ratio*=1.29, $t(1842)=2.62$, $p<.01$. As displayed in Figure 3a, participants in the limited resource
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53 theory condition exhibited ego-depletion, making more mistakes after the depleting task than
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55 after the non-depleting task. There was no difference for participants in the nonlimited resource
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3 theory condition. Separate analyses for the two theory groups confirmed that the difference
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5 between the non-depleting and depleting conditions was significant for the limited resource
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7 theory condition, $\beta=.59$, *odds ratio*=1.81, $t(979)=8.59$, $p<.01$, but not for the nonlimited resource
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9 theory condition, $t(859)<1$.

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12 Next we examined IQ performance. The same pattern emerged. The interaction between
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14 theory condition and depletion condition was significant, $\beta=.48$, *odds ratio*=1.62, $t(610)=2.81$,
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16 $p<.01$. As displayed in Figure 3b, participants in the limited resource theory condition made
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18 more mistakes after the depleting task than after the non-depleting task, $\beta=.33$, *odds ratio*=1.39,
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20 $t(324)=2.85$, $p<.01$. Participants in the nonlimited resource theory condition did not vary by
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22 depletion condition, $t(284)<1$.

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25 Next we examined subjective exhaustion. First, we tested whether theories about
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27 willpower affected participants' experience of exhaustion. We conducted a 2 (theory condition)
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29 \times 2 (depletion condition) ANOVA. Only the main effect of depletion condition was significant,
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31 $F(1,76)=6.69$, $p<.05$, $\eta^2=.08$. Participants experienced the e-crossing task as more exhausting in
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33 the depleting condition ($M=4.59$, $SD=2.29$) than in the non-depleting condition ($M=3.31$,
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35 $SD=2.03$). Neither the main effect of theory condition nor the interaction was significant, $F_s<1$.
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37 Thus the induced theory of willpower did not affect the degree to which participants experienced
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39 the e-crossing task as exhausting.

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42 Second, we tested whether theories about willpower moderated the effect of felt
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44 exhaustion on subsequent performance. We ran the same Logistic HLM model as above
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46 replacing the depletion condition with self-reported exhaustion (centered). The interaction
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48 between self-reported exhaustion and theory condition was significant, $\beta=.17$, *odds ratio*=1.19,
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50 $t(1842)=3.58$, $p<.01$ (see Figure 3c). Separate analysis for each theory condition show that self-
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3 reported exhaustion predicted more mistakes in the limited resource theory condition, $\beta=.09$,
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5 *odds ratio*=1.09, $t(979)=6.18$, $p<.01$, but not in the nonlimited resource theory condition,
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7 $t(859)<1$. We conducted the same analyses with accuracy on the IQ problems as the dependent
8
9 variable. Again, only the interaction was significant, $\beta=.22$, *odds ratio*=1.25, $t(610)=2.67$, $p<.01$,
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11 revealing the same pattern of results.
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16 Finally, we examined whether the altered relationship between exhaustion and Stroop
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18 performance mediated the effect of implicit theories on ego-depletion (see Figure 4). We ran
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20 Logistic HLM models with accuracy on the Stroop task and IQ problems as dependent variables.
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22 Predictors were the two experimental conditions (theory and depletion condition), their
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24 interaction, self-reported exhaustion, and the interaction between self-reported exhaustion and
25
26 theory condition. For accuracy on the Stroop task, the interaction between self-reported
27
28 exhaustion and theory condition remained significant, $\beta=.19$, *odds ratio*=1.21, $t(1840)=5.51$,
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30 $p<.01$, but the interaction between depletion condition and theory condition was no longer
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32 significant, $\beta=.07$, *odds ratio*=1.07, $t(1840)=.64$. Similarly, for accuracy on the IQ problems,
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34 only the interaction between self-reported exhaustion and theory condition remained significant,
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36 $\beta=.18$, *odds ratio*=1.21, $t(609)=2.15$, $p<.05$. The results suggest that self-reported exhaustion in
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38 interaction with induced resource theory mediated the depletion condition \times theory condition
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40 effect on performance on both the Stroop task and the IQ problems.
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47 In sum, Study 3 yielded no evidence that a nonlimited resource theory led participants to
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49 overuse their self-control resources. After a depletion manipulation, participants in the
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51 nonlimited resource theory condition showed no evidence of resource depletion even on a series
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53 of subsequent tasks. Further, implicit theories about willpower did not affect the experience of
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55 the depleting task as exhausting. Instead, implicit theories affected the relationship between the
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3 experience of exhaustion and subsequent performance. People with a nonlimited resource theory
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5 felt just as exhausted as those with a limited resource theory but for them exhaustion did not
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7 undermine subsequent performance.
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10 Study 4

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12 Studies 1-3 showed that measured and induced theories about willpower as a limited vs.
13
14 nonlimited resource moderate ego-depletion in a classic laboratory paradigm. Study 4 examined
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16 the effect of implicit theories about willpower on people's everyday self-regulation and goal-
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18 striving. Consistent with our previous findings, we hypothesized that the nonlimited resource
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20 theory would predict better self-regulation during times of stress and high self-regulatory
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22 demands. Therefore, Study 4 tracked college students across three time points, the last of which
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24 occurred during final exams. We expected implicit theories about willpower at the second time
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26 point to predict self-regulation during final exams, but we did not expect prediction at the prior
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28 time points when self-regulatory demands were lower.
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33 *Method*

34 *Participants and Procedure*

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37 An initial web-questionnaire was completed by 101 Stanford undergraduates. Of these, a
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39 subsample of 44 participants completed measures at the second time point. In the critical
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41 comparison, 41 of those 44 participants (30 women) also completed measures at the third time
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43 point. Participants in the final sample did not differ on any measure from participants who
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45 completed measures at the first time point but who did not continue in the study. The first
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47 measurement occurred in April, at the beginning of the academic quarter (T1), the second in May
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49 (T2), and the third in the first week of June (T3), during final exams.
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53 *Measures*

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3 The same measures were assessed at each time point. First, we assessed individual
4 differences in implicit theories about willpower using a 12-item questionnaire, the 6 items used
5 previously plus 6 new items that referred to resistance to temptation as a further aspect of self-
6 control (see Table S1). Items were recoded so that higher values represent agreement with a
7 limited resource theory. The scale was reliable, $\alpha(T1)=.77$, $\alpha(T2)=.86$, $\alpha(T3)=.89$, and the
8 measure showed high reliability across the three time points (test-retest $r_s>.77$).
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17 Second, we assessed participants' everyday efforts at self-regulation by examining
18 reported consumption of unhealthy foods and reported procrastination. Participants were asked
19 how often in the previous week they had consumed several high fat/high sugar foods and drinks.
20 They were also asked how often they had engaged in various nonacademic activities rather than
21 studying (e.g., "How often did you watch TV instead of studying?") (1=*never*, 7=*two or more*
22 *times per day*).
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31 Third, we assessed participants' self-regulation with respect to a personal goal using a
32 procedure developed by Brunstein, Schultheiss, and Grässmann (1998). At T1 participants listed
33 a personal goal that involved challenge and achievement. This goal was presented to participants
34 at each time point and they were asked how well they had self-regulated in pursuing it (5-items,
35 e.g., "I was often not in the mood to do something for this goal"; 1=*strongly disagree*,
36 5=*strongly agree*), $\alpha(T1)=.69$, $\alpha(T2)=.86$, $\alpha(T3)=.81$.
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46 *Results and Discussion*

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48 The hypothesis that implicit theories about willpower affect self-regulation when
49 demands on self-regulation are high implies that a limited resource theory at T2 should predict
50 worse self-regulation at T3. To test this hypothesis, in the first set of analyses self-regulation
51 variables at T3 were regressed on implicit theories at T2 controlling for self-regulation at T2.
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3 These analyses revealed that a limited resource theory at T2 predicted worse self-regulation on
4 all three measures at the stressful time point, T3: Consumption of unhealthy food, $b=.41$,
5 $\Delta R^2=.16$, $\Delta F(1,38)=11.76$, $p<.01$, procrastination rather than studying, $b=.29$, $\Delta R^2=.08$,
6 $\Delta F(1,38)=8.11$, $p<.01$, and self-regulation with respect to personal goal-striving, $b=-.27$,
7 $\Delta R^2=.06$, $\Delta F(1,38)=5.80$, $p<.05$, as well as a composite index of all three measures of self-
8 regulation⁵, $b=.51$, $\Delta R^2=.20$, $\Delta F(1,38)=24.71$, $p<.001$. The more participants agreed with a
9 limited resource theory at T2 the more they reported eating unhealthy food, procrastinating, and
10 self-regulating ineffectively while pursuing an important goal at T3.
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22 Next we tested the reverse causal relationship—from self-regulation at T2 to implicit
23 theories at T3. Implicit theories at T3 were regressed on T2 self-regulation controlling for T2
24 implicit theory. These analyses yielded no significant relationship between T2 self-regulatory
25 variables and T3 implicit theory, $\Delta F(1,38)<1.30$.
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32 The same analyses were repeated with the same sample using self-regulation variables
33 and implicit theories between T1 and T2. As predicted, no relationship in either direction was
34 significant.
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39 The results support the hypothesis that the nonlimited theory of willpower predicts better
40 self-control during periods of heightened stress and self-regulatory demands. Of course, the
41 results do not imply that a nonlimited theory will always produce better self-regulation. In times
42 of low stress, the limited theory could prove superior (see Study 2), an interesting possibility to
43 explore in future research.
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50 General Discussion

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53 In a classic laboratory paradigm (Studies 1-3), only people who thought of or who were
54 led to think of willpower as a limited resource showed ego-depletion. By contrast, for people
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3 with or led to adopt a nonlimited resource theory, a demanding initial task did not undermine
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5 subsequent performance. In one study, the demanding task actually raised their subsequent
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7 performance. Further, Study 4 showed that the more people held a limited resource theory the
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9 poorer was their self-regulation in the real world when demands on self-control were high.
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13 According to the strength model of self-control, motivational factors that counteract ego-
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15 depletion effects such as expectancies or incentives may do so because motivation can
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17 compensate for the lack of self-regulatory strength to some degree (Baumeister & Vohs, 2007;
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19 Muraven et al., 2006). It is argued that this motivation can lead people to expend even more of
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21 the depleted psychological resource, leaving less available for subsequent tasks. This process did
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23 not account for the effects of implicit theories about willpower. In Study 3, people led to adopt a
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25 nonlimited resource theory performed better than people with a limited resource theory not only
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27 on the task immediately following the depleting task (i.e., the Stroop task) but even on a third
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29 task (i.e., IQ problems).
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35 Study 3 also suggests a mechanism for ego-depletion and for how implicit theories
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37 sustain self-control. Perceived exhaustion mediated the effects of the depletion manipulation in
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39 the limited resource condition. These findings are consistent with recent research showing that
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41 depletion effects are better predicted by peoples' perception of depletion than by an actual
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43 depletion experience (Clarkson, Hirt, Jia, & Alexander, 2010). Our findings further imply that
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45 implicit theories changed how people responded given their level of perceived exhaustion on the
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47 initial task. Among people led to adopt a limited resource theory, the more exhausted they felt
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49 the worse they subsequently performed. But for people led to adopt a nonlimited resource theory
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51 there was no relationship between perceived exhaustion and subsequent performance. For them,
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53 exhaustion was not a sign to reduce effort.
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3 Taken together, the results suggest that at least in some cases ego-depletion may result
4 not from a true lack of resources after an exhausting task but from people's beliefs about their
5 resources. We do not question that biological resources contribute to successful self-control
6 (Gailliot & Baumeister, 2007; Gailliot et al., 2007). But these resources may be less limited than
7 is commonly supposed. A key direction for future research is to examine how top-down
8 processes (e.g., theories about willpower) and bottom-up processes (e.g., the availability of
9 glucose) interact to affect self-control.
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20 Psychological research has the power to shape how people think about themselves
21 (Herman, 1996). People who learn about the strength model of self-control may conclude that
22 they are at the mercy of a fixed, physiological process that limits their willpower. It is important
23 for people to understand that their own beliefs about willpower as a limited or nonlimited
24 resource can affect their self-regulation. It is also important for psychologists to appreciate the
25 impact of powerful and widely-shared lay theories about the self and to distinguish their effects
26 from seemingly immutable biologically-driven processes.
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Footnotes

¹ Age (centered) as a covariate on the participant level was included in all models based on previous research that shows it relates to Stroop performance. The population average model was used in all analyses.

² The two groups (limited vs. nonlimited resource theory) were created using a median split to allow for the calculation of contrasts within HLM.

³ A possible alternative explanation is that people with a nonlimited resource theory have better self-control. In contrast to this possibility, a pilot study ($N=65$) did not find a negative relationship between a limited resource theory and trait self-control (Schwarzer, Diehl, & Schmitz, 1999), $r=.17$, $p>.20$.

⁴ To test whether effort took on a different (positive vs. negative) meaning for the two theory groups, we administered a brief word categorization task following the depletion manipulation. The task did not yield clear results and so is not discussed further.

⁵ After reverse-scoring achievement goal self-regulation, the three indicators were standardized and averaged.

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This research was supported by the Swiss National Foundation (SNF). We thank Katharina Bernecker, Alena Friedrich, Yousuf Haq, Krishna Savani, and Rebecca Wheeler for invaluable assistance and Geoffrey Cohen and the Dweck-Walton Lab for helpful comments.

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Figure Captions

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Figure 1. Probability of making a mistake on incongruent trials of the Stroop task as a function of ego-depletion condition and implicit theories about willpower. The limited resource theory group represents participants 1 SD above the mean on the implicit theories measure. The nonlimited resource theory group represents participants 1 SD below the mean on the implicit theories measure (Study 1).

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Figure 2. Probability of making a mistake on incongruent trials of the Stroop task as a function of ego-depletion condition and implicit theories about willpower condition (Study 2).

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Figure 3. Probability of making a mistake on (a) incongruent trials of the Stroop task and (b) IQ task as a function of ego-depletion condition and implicit theories about willpower condition; (c) probability of mistakes on incongruent trials of the Stroop task as a function of experienced exhaustion and implicit theory condition (Study 3).

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Figure 4. Mediation analysis (Study 3): Self-reported exhaustion mediates ego-depletion for people in the limited resource theory condition but not for people in the nonlimited resource theory condition.

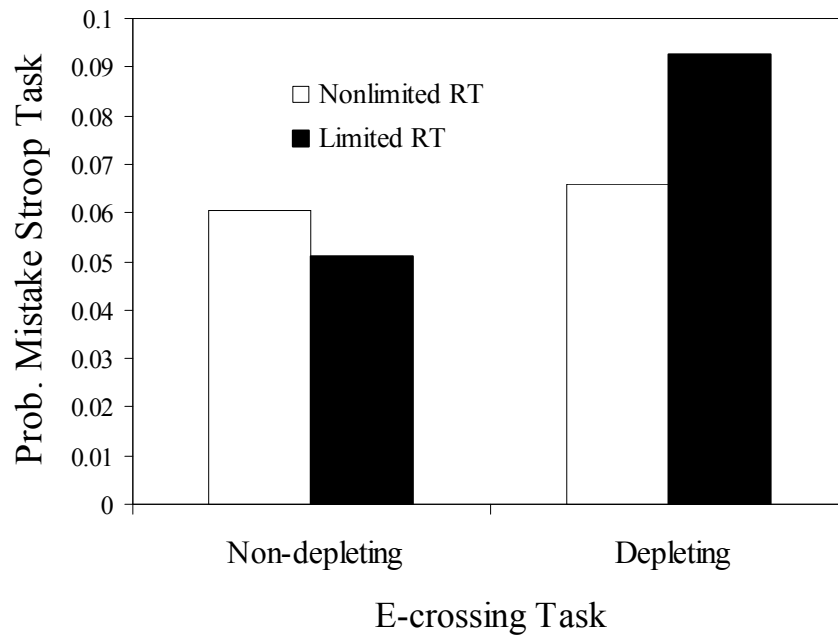


Figure 1

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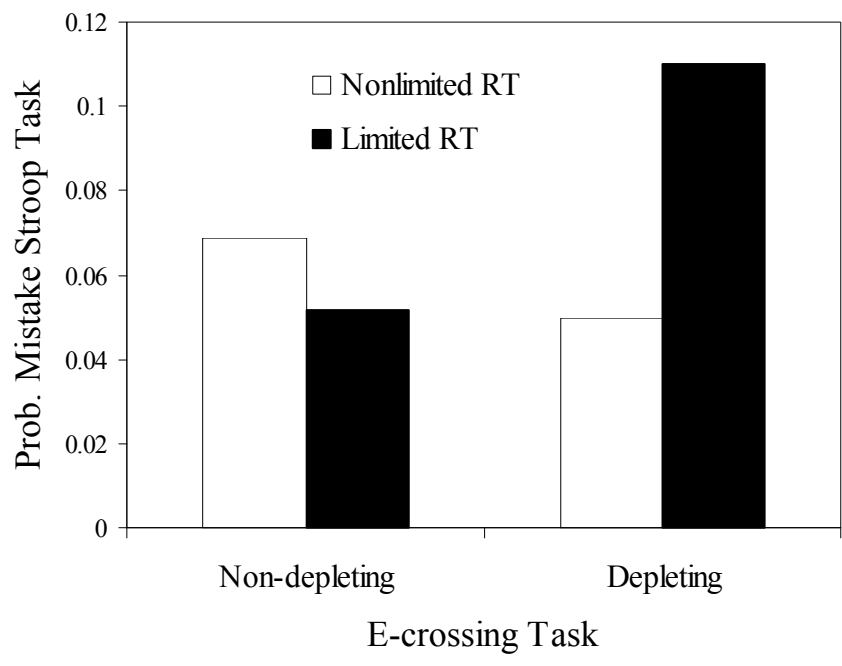


Figure 2

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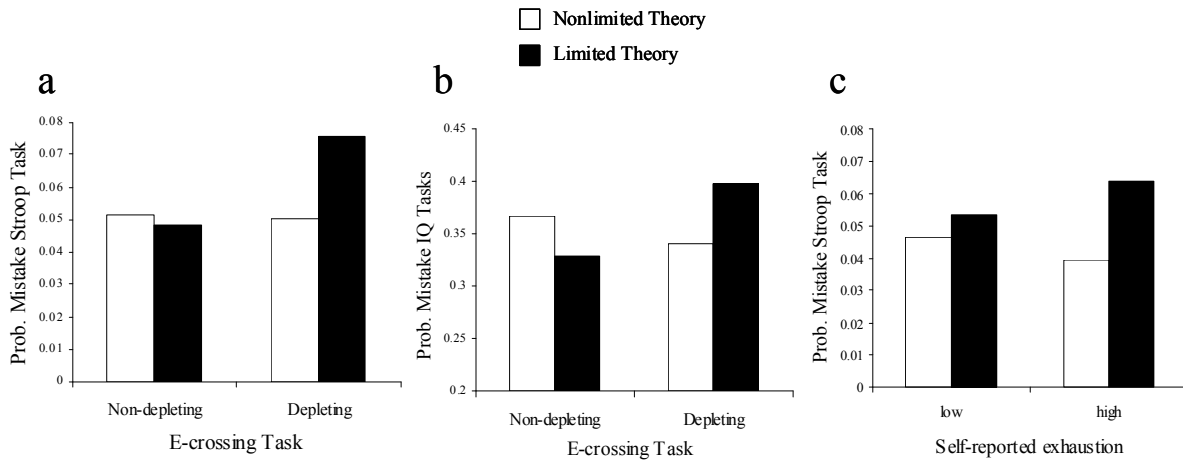


Figure 3

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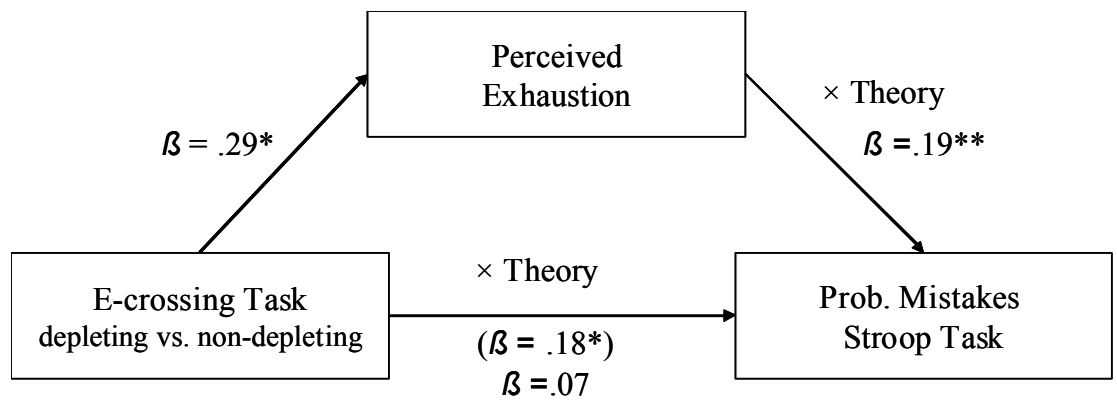


Figure 4

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