

Reverse Ego-Depletion: Acts of Self-Control Can Improve Subsequent Performance in Indian Cultural Contexts

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The *strength model of self-control* has been predominantly tested with people from Western cultures. The present research asks whether the phenomenon of ego-depletion generalizes to a culture emphasizing the virtues of exerting mental self-control in everyday life. A pilot study found that whereas Americans tended to believe that exerting willpower on mental tasks is depleting, Indians tended to believe that exerting willpower is energizing. Using dual task ego-depletion paradigms, Studies 1a, 1b, and 1c found reverse ego-depletion among Indian participants, such that participants exhibited better mental self-control on a subsequent task after initially working on strenuous rather than nonstrenuous cognitive tasks. Studies 2 and 3 found that Westerners exhibited the ego-depletion effect whereas Indians exhibited the reverse ego-depletion effect on the same set of tasks. Study 4 documented the causal effect of lay beliefs about whether exerting willpower is depleting versus energizing on reverse ego-depletion with both Indian and Western participants. Together, these studies reveal the underlying basis of the ego-depletion phenomenon in culturally shaped lay theories about willpower.

Keywords: ego-depletion, culture, motivation, lay beliefs about willpower, implicit theories

During the past two decades, dozens of studies have documented that after people have exerted self-control in an initial task, their capacity to continue exerting self-control in subsequent tasks can be impaired—a phenomenon called *ego-depletion* (see Hagger, Wood, Stiff, & Chatzisarantis, 2010, for a meta-analysis). The first theory explaining this effect, the *strength model of self-control*, argued that any act of self-control depletes one's limited mental resource, leaving people with fewer self-control resources to expend on subsequent tasks (Baumeister, Bratslavsky, Muraven, & Tice, 1998; Baumeister, Vohs, & Tice, 2007). As such, ego-depletion has been proposed to be a physiology-based pan-human phenomenon (Gailliot & Baumeister, 2007).

Recent research and theorizing, however, has questioned the physiological conceptualization of the ego-depletion effect and

instead proposed alternative motivational accounts (Inzlicht & Schmeichel, 2012; Inzlicht, Schmeichel, & Macrae, 2014; Kitayama & Tompson, 2015; Kurzban, Duckworth, Kable, & Myers, 2013; Molden et al., 2012). A recent meta-analysis has suggested that the ego-depletion effect might not even exist (Carter, Kofler, Forster, & McCullough, 2015). Further, results from a recent multilab replication project indicate that the ego-depletion effect could not be replicated on one set of tasks (Hagger et al., 2016).¹

The present article aims to contribute a novel theoretical advancement in this area by documenting *reverse ego-depletion* with cognitive tasks in a non-Western culture. We argue that culturally varying lay theories about willpower are important factors influencing the ego-depletion effect.

The Strength Model of Self-Control

The original account of ego-depletion claimed that the capacity to exert self-control is a limited resource; initial acts of self-control

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¹ However, caution should be exercised before asserting that the ego-depletion effect does not exist. The meta-analytic conclusion advocated by Carter, Kofler, Forster, and McCullough (2015) might be premature because the analytic method used (PET-PEESE) seemingly assumes a homogenous underlying effect size, an assumption that is unlikely to be met in an area of research that uses as diverse a range of independent and dependent measures as the ego-depletion literature. Similarly, the failed multicountry preregistered replication (Hagger et al., 2016) used only one pair of tasks that was administered in a different setting than the original study (Sripada, Kessler, & Jonides, 2016), and using a dependent measure that is not representative of those used in the ego-depletion literature (Baumeister & Vohs, 2016). A second multilab preregistered replication attempt of the ego-depletion effect is currently underway (Baumeister & Vohs, 2016). Thus, more research is required to decide whether the ego-depletion effect is reliable and replicable.

deplete this resource, thus impairing people's ability to exert self-control subsequently (Baumeister et al., 1998; Baumeister & Heatherton, 1996; Baumeister, Heatherton, & Tice, 1994; Muraven & Baumeister, 2000). Predictions of the strength model of self-control have been confirmed by over 100 studies conducted using a diverse range of tasks (Hagger et al., 2010), making the strength model one of the most influential social psychological theories in the 21st century.

Despite the amassed evidence, research on psychological factors that influence the ego-depletion effect has fundamentally questioned the strength model of self-control. For example, people's subjective perception of effort expended on the initial task, not the actual effort expended, predicted their performance on subsequent tasks (Clarkson, Hirt, Jia, & Alexander, 2010). This finding is incompatible with the strength model. Further, manipulations that are unlikely to influence potential physiological bases of self-control, such as self-affirmation (Schmeichel & Vohs, 2009), self-monitoring (Wan & Sternthal, 2008), action orientation (Dang, Xiao, Shi, & Mao, 2015), positive affect (Tice, Baumeister, Shmueli, & Muraven, 2007), personal prayers (Friese & Wänke, 2014), and monetary incentives (Muraven & Slessareva, 2003), reduce or eliminate the ego-depletion effect. Together, these findings support a motivational rather than a physiological account of ego-depletion, suggesting that after people exert self-control on one task, they are sometimes less motivated to exert self-control on subsequent tasks (Kitayama & Tompson, 2015).

Lay Theories About Willpower

An additional stream of research has found that whether people exhibit ego-depletion is significantly shaped by their lay theories. Individuals who believe that willpower is limited (i.e., that exerting willpower on a strenuous mental activity reduces the amount of willpower available for a subsequent strenuous task) exhibit ego-depletion. In contrast, individuals who believe that willpower is nonlimited (i.e., that exerting self-control on a strenuous mental activity does not reduce the amount of willpower available for a subsequent task) do not exhibit the ego-depletion effect in the standard dual-task paradigm (Job, Dweck, & Walton, 2010; Vohs, Baumeister, & Schmeichel, 2012). Among undergraduate students who were taking a heavy course load, those who believed that willpower is nonlimited procrastinated less and ultimately earned higher grades (Job, Walton, Bernecker, & Dweck, 2015). This stream of research suggests that people's beliefs about willpower shape their willingness to exert self-control in the face of accumulating self-control demands.

Research on beliefs about willpower has shown that whether people believe that willpower is limited or that willpower is nonlimited predicts performance after people have exerted self-control on a previous task or not (Job et al., 2010, 2015). Yet could there exist an *energizing belief*, the idea that willpower exertion is not just nondepleting but motivating; that once people have exerted willpower in an initial task, they would perform not worse or the same but *better* on subsequent tasks? This idea has not been conceptualized previously in the ego-depletion literature as past research has largely focused on lay beliefs predicting the presence or absence of ego-depletion, not its reversal.

Research on lay beliefs about willpower has found that overall, American and European participants tend to agree with the limited

theory (Job et al., 2010, 2015), which could explain why a number of studies conducted in Western countries have found that people exhibit the ego-depletion effect (Hagger et al., 2010; but see Carter et al., 2015; Hagger et al., 2016). However, as lay theories are shaped by culture (e.g., Chiu, Dweck, Tong, & Fu, 1997; Rattan, Savani, Naidu, & Dweck, 2012), the question arises: Are there cultural differences in the ego-depletion effect, and perhaps more interestingly, in whether people believe that willpower exertion is energizing and motivating? Philosophical traditions and modern schooling practices suggest Indian cultural contexts as a possible candidate.

Lay Theories About Willpower in South Asian Indian Contexts

Numerous religious traditions originating in India, including Hinduism, Jainism, and Buddhism, advocate not just monks and nuns but even lay people to exert mental self-control in their daily lives. Examples of everyday self-control include extended sessions of daily prayers (Mosher, 2005), concentration (Bronkhorst, 1993; Sivananda, 2001), and meditation (Walsh & Shapiro, 2006; cf. Sen, 1997). The idea is that exerting cognitive self-control helps correct mental imbalances, helping individuals make more rational decisions subsequently (Wallace & Shapiro, 2006). For example, a common concentration technique taught to children and adolescents is focusing their eyes and minds completely on the flame of a candle in a dark room, without blinking or looking elsewhere and without thinking of anything else, for 10 to 20 minutes. Recent research found that this visual concentration task improved subsequent cognitive performance on the Stroop task (Raghavendra & Singh, 2015).

The emphasis on mental self-control is evident in India's schooling system. An experience sampling study found that middle-class Indian students spent 34% of their waking hours in school-related activities (Verma, Sharma, & Larson, 2002), compared with about 24% in the U.S. (see Larson & Verma, 1999, Table 3). A survey conducted in 2004 to 2005 among middle-class late adolescents and young adults found that Indians spent the most amount of time reading books, 10.7 hours on average per week, compared with people in 29 other countries (the Americans surveyed spent 5.7 hr per week on average; NOP World, 2005). Middle school Indian students spend about 10 more hours per week on cognitively challenging math and science topics than U.S. students (Makel, Wai, Putallaz, & Malone, 2015). On average, American students spend 1 hour per day on homework (U.S. Department of Education, 2008), whereas Indian students spend over 3 hours per day (Lloyd, Grant, & Ritchie, 2008).

The emphasis on devoting long hours to education in India indicates the prevalence of the belief that people have the capacity to exert mental self-control for extended duration. In contrast, educational reforms in the U.S. starting from the 19th century reflect a belief that people do not have the capacity to exert mental self-control for extended periods, as argued by Gold (2002, pp. 82–84):

For [19th century school superintendents], a grave danger came from exerting too much energy towards learning for too long a period of time . . . Most educators condemned excessive educational practices, and they identified a variety of negative results that would ensue from too much schooling . . . [especially] mental fatigue . . . [School

reformers in the 19th century] strove to reduce time spent studying, because long periods of respite could save the mind from injury. Hence the elimination of Saturday classes, the shortening of the school day, and the lengthening of vacation . . . Teachers were cautioned that “when [students] are required to study, their bodies should not be exhausted by long confinement, nor their minds bewildered by prolonged application.”

The question that we ask in the present research is whether modern people inhabiting cultural contexts that are seeped with philosophical traditions and daily realities that advocate and require acts of mental self-control are likely to believe that exerting mental self-control is energizing. We further ask whether this belief would be reflected in a reverse ego-depletion effect, such that after people have exerted self-control on initial cognitive tasks, they would perform better on subsequent intellectual tasks. We first review past research on cultural differences in ego-depletion and then elaborate upon this idea.

Ego-Depletion and Culture

Given that the strength model of self-control was developed by researchers in North America, it is not surprising that nearly all the research on ego-depletion has been conducted with participants from Western countries. To our knowledge, only one published study compared Westerners and non-Westerners on ego-depletion using the standard dual-task paradigm (Seeley & Gardner, 2003, Study 1). In this study, the researchers found that U.S. citizens at a U.S. university who were initially asked to engage in self-control by suppressing their thoughts performed worse on a subsequent handgrip task than those who were not asked to suppress their thoughts. In contrast, Asian citizens at the same university performed equally well in the two conditions. This initial finding suggests that ego-depletion might be a culturally specific phenomenon. To our knowledge, there is no published research following up on this finding. In the present research, we investigate whether people in Indian cultural contexts hold different beliefs about whether willpower is limited or energizing than Americans, and also respond to strenuous mental activity differently.

Some cross-cultural research suggests that Asians are more motivated to work on a subsequent task after they have completed a strenuous task rather than a nonstrenuous task. In a study aimed at investigating cultural differences in self-improvement motivation, Heine et al. (2001, Study 1) gave North American and Japanese participants either an easy or a difficult version of the remote associations test that lasted 8 min. In the easy version of the test, participants got seven of the 10 items correct on average, whereas the difficult version, they got only 1.7 items correct on average. It seems reasonable to assume that participants in the difficult condition found the task more strenuous than those in the easy condition. After this task, participants had the opportunity to work on more such puzzles for up to 15 min while the experimenter was away. The key outcome was the amount of time that participants voluntarily spent working on additional puzzles.

The strength model of self-control would predict that in the difficult condition, participants' mental resources were more depleted than in the easy condition, so they would persist less on the subsequent task. That is exactly what the researchers found with the North American participants. Yet Japanese participants persisted more on the second set of puzzles after initially working on

difficult puzzles rather than easy puzzles, appearing to be more motivated after engaging in a strenuous task rather than a non-strenuous task. Heine et al.'s (2001) study suggests the possibility of important cultural differences in the ego-depletion phenomenon. However, it is somewhat different from typical ego-depletion studies, which test how an initial easy versus difficult task requiring self-control influences participants' performance on a subsequent, different task that is not voluntary in nature. In contrast, Heine et al.'s (2001) study examined how an initial easy versus difficult task influenced subsequent voluntary persistence on the same task.

Hypotheses

Drawing on Indian philosophical traditions emphasizing mental self-control in daily life, and on cross-cultural differences in schooling practices, along with the findings of Heine et al. (2001) and Seeley and Gardner (2003), we propose the following hypotheses: (a) In Indian contexts, people tend to believe that exerting willpower on strenuous mental tasks is energizing, whereas in U.S. American contexts, people tend to believe that exerting willpower on strenuous mental tasks is depleting. (b) These beliefs are reflected in people's performance: Indian participants would be expected to exhibit reverse ego-depletion in the standard dual task paradigm, whereas Westerners would not be expected to exhibit reverse ego-depletion. (c) Further we hypothesized that people's beliefs about willpower would influence whether they exhibit the reverse ego-depletion effect. That is, the more people believe or are led to believe that exerting willpower is energizing, the more likely they would be to exhibit the reverse ego-depletion effect.

Overview of Studies

We conducted six studies to assess our hypotheses. A pilot study tested our basic assumption that people in Indian cultural contexts believe that exerting willpower is energizing, whereas Americans tend to believe that exerting willpower is depleting. Studies 1a, 1b, and 1c tested whether Indians exhibit reverse ego-depletion using the standard dual task paradigm used in the ego-depletion literature. Next, Studies 2 and 3 tested whether the reverse ego-depletion effect observed in the previous studies is specific to India and not evident with participants from Western countries (the U.S. and Switzerland). Study 3 further tested whether people who more strongly believe that exerting willpower is energizing would be more likely to exhibit the reverse ego-depletion effect. Finally, Study 4 tested whether beliefs about willpower exert a causal effect on reverse ego-depletion. Specifically, we tested whether participants exposed to the idea that exerting willpower is energizing would exhibit the reverse ego-depletion effect. In contrast, we did not expect participants who were told that exerting willpower is depleting to exhibit the reverse ego-depletion effect. Given our theorizing that Indians' belief that exerting willpower is energizing largely applies to self-control in the mental domain, we used a number of different cognitive tasks in the present studies to test the hypotheses. No participants were excluded from any of the studies except those noted in the study method sections. All experimental manipulations and self-control tasks are reported.

Pilot Study

A pilot study tested our basic assumption that Indians would tend to believe that exerting willpower is energizing. We also included an American sample in the present study. Based on previous research, we expected Americans would believe that exerting willpower is depleting (Job et al., 2010).

Method

Participants. Surveys seeking residents of India and the U.S. were posted on Amazon Mechanical Turk. In response, 454 Americans and 397 Indians completed the study. Of these, we excluded 22 participants who were not citizens of their respective countries, leading to a final sample of 382 Indians (127 women, 255 men; mean age 31.66 years; 95% with a college degree) and 447 Americans (259 women, 187 men, one unreported; mean age 36.25 years; 49% with a college degree).

Procedure. Participants were presented with the following four items measuring whether they believed that willpower exertion was relatively more depleting or energizing:

1. Imagine you are working on a very difficult task that requires your full concentration for 1 hr. Do you believe that right after this, you would feel tired and sleepy, or would you feel fresh and energetic?
2. Imagine you are working on a very difficult task that requires a lot of concentration for 1 hr. Do you believe that right after this, would it be *more easy* to concentrate on a different task that is also difficult and requires a lot of concentration, or would it be *less easy* to concentrate on another difficult task?
3. Imagine you are working on a very difficult task that requires a lot of concentration for 1 hr. Do you believe that immediately after this, you would need a break before you can work on another difficult task that also requires a lot of concentration, or would you be able to concentrate on another difficult task right away without any break?
4. Imagine you are working on very difficult math problems that require a lot of concentration for 1 hr. Do you believe that immediately after this, you would make more silly mistakes on a difficult math test that requires a lot of concentration, or would you make less silly mistakes on a difficult math test?

Participants responded on 20-point bipolar scales with endpoints drawn from the item text. This scale was newly developed because previously developed items used by Job, Dweck, and Walton (2010) assessed beliefs about whether willpower is limited or unlimited. The present items extend the unlimited pole further toward the idea that exerting willpower is energizing.

Results

We used a uniform data analysis procedure across all experiments. The procedure was determined in advance based on prior research and was consistently applied across all studies. As is

common in cross-cultural research (Cohen, 2010), given possible differences in gender, age, and socioeconomic status (SES) between the two cultural groups, we conducted initial analyses in this and all subsequent studies to test whether participants' gender, age, and SES independently predict the dependent measure. Demographic variables that were significant predictors in these initial analyses were included in the subsequent analyses as covariates. We used participants' own education level (for community adult samples) or their parents' education level (for student samples) as an indicator of their SES (Snibbe & Markus, 2005).

Participants' responses to the four items measuring their beliefs about willpower were intercorrelated, $\alpha = .70$, so we averaged them. Initial analyses indicated that participants' age was not related to their beliefs about willpower, $p = .47$, but men were more likely than women to hold the energizing belief, $p = .001$, as were participants with high SES, $p < .001$. An ANOVA with beliefs about willpower as the dependent measure, culture as the main predictor, gender, and SES as covariates found that Indians were more likely than Americans to believe that exerting willpower is energizing, $F(1, 824) = 109.93, p < .001,^2 M_{\text{Americans}} = 8.25, SE = 0.22, M_{\text{Indians}} = 11.90, SE = 0.24, \text{Cohen's } d = .84, 95\% \text{ CI } [.70, .98]$. Neither gender nor SES was significant, p 's $> .37$.

Next, we compared the mean response within each cultural group to the scale midpoint. A one-sample t test confirmed that Indians' mean score was significantly above the scale midpoint, indicating that on average, they tended to believe that willpower exertion is energizing, $t(382) = 11.86, p < .0001, M = 11.86, SD = 4.47$. In contrast, Americans' mean score was significantly below the scale midpoint, indicating that on average, they tended to believe that willpower exertion is depleting, $t(447) = 11.60, p < .0001, M = 8.29, SD = 4.03$.

Discussion

The pilot study confirmed our hypothesis that Indians tend to believe that exerting willpower is energizing, thinking that exerting willpower on an initial strenuous task would help them exert willpower on a subsequent strenuous task. In contrast, Americans tended to believe that exerting willpower on mental tasks is depleting, thinking that exerting willpower on one strenuous task would make it more difficult for them to perform and concentrate on a second strenuous task. A key question then arises: Could the prevalent belief among Indian participants, that exerting willpower is energizing, become a self-fulfilling prophecy, leading Indians to perform *better* on a subsequent task requiring cognitive self-control after an initial mentally strenuous task?

Studies 1a, 1b, and 1c

Studies 1a, 1b, and 1c tested whether the pattern of ego-depletion observed with Indian participants matches the culturally prevalent lay belief, the idea that exerting willpower is energizing. Specifically, we tested whether Indians exhibit a reverse ego-depletion effect on cognitive tasks.

² One participant dropped from the analyses because of missing demographic information.

In the experimental manipulation of Study 1a, we manipulated the initial strenuous versus nonstrenuous task by asking participants to solve easy versus difficult mazes. We then measured participants' performance on the modified Stroop task, which has been used over a dozen times as a dependent measure in the ego-depletion literature (see Hagger et al., 2010, Appendix A, p. 6). In Study 1b, we manipulated cognitive control with a Stroop task by presenting participants with all-congruent versus all-incongruent Stroop trials. This procedure has been frequently used as a manipulation in the ego-depletion literature (see Hagger et al., 2010, Appendix A, p. 3). Further, we used performance on a timed word search puzzle task as the dependent measure. In Study 1c, we used an attention control task in the experimental manipulation, which, too, has been used over a dozen times as an ego-depletion manipulation (see Hagger et al., 2010, Appendix A, p. 3). It was followed by the digit-symbol substitution task, which is a subtest of the Wechsler Adult Intelligence Scale (WAIS-R; Wechsler, 1981).

We hypothesized that Indian participants who completed the strenuous mental task initially (difficult mazes, the all-incongruent Stroop task, controlled attention) would perform better on the subsequent cognitive task (Stroop task, word search puzzle, digit-symbol substitution) compared with those who completed the nonstrenuous task initially (easy mazes, all-congruent Stroop task, unrestricted attention).

Study 1a Method

Participants. Participants were 77 undergraduates (47 women, 30 men; mean age 20.48 years; 53 with and 24 without at least one college-educated parent) at the M. S. Ramaiah Institute of Technology in Bangalore, India. Participants were randomly assigned to either the strenuous condition or the nonstrenuous condition. The study was conducted in English, given that English was the language of instruction at the university.

Manipulation. Participants were given a packet with a series of mazes and were asked to solve as many mazes as they could in 10 min. In the nonstrenuous condition, the mazes were small in size, 15 × 15, and thus were easy to solve. Participants were provided with 42 mazes printed on seven pages. In the strenuous condition, the mazes were very large in size, 70 × 70, and thus were nearly impossible to solve in the allotted time. Participants were provided with seven mazes printed on seven pages.

Dependent measure. After 10 min, the computer alerted participants and asked them to proceed to the next task. The dependent measure was the modified Stroop task, which has been used in over a dozen studies to measure participants' self-control capacity after a depletion manipulation (see Carter et al., 2015, Table 1; Hagger et al., 2010, Appendix A, p. 6). Participants were told that they would see the words *blue*, *green*, *yellow*, or *red* written in either blue, green, yellow, or red font colors on the screen. Participants were asked to press the buttons 1, 2, 8, and 9, respectively, based on the color of the font (a legend at the bottom of the screen specified which button had to be pressed for which color). In 24 trials, the words were depicted in the same color that they referred to (e.g., *blue* displayed in blue color), whereas in the remaining 24 trials, the words were depicted in a different color than the one that they

referred to (e.g., *blue* displayed in green color). Participants were instructed to keep their fingers on the four keys throughout the task and to respond as quickly as possible while still being accurate. Participants did not receive any accuracy feedback as they went through the task. The key dependent measure was the Stroop interference effect: the increase in response time when the meaning and font color of the stimuli were incongruent compared with trials in which they were congruent.

Study 1a Results

Given that average accuracy on the Stroop task is typically around 95%, past research has used an accuracy threshold of 80% for including participants in the analyses (e.g., Liu, Wang, Corby, Zhang, & Joseph, 2006; Sripada, Kessler, & Jonides, 2014). Seven participants with accuracy of less than 80% on the Stroop task were excluded from the analysis. As is standard practice when analyzing the Stroop incongruence effect, trials on which participants made incorrect responses, 4.88% of all trials, were excluded from the analyses.

To reduce the rightward skew in the distribution of response times in the Stroop task, we computed the mean and standard deviation of each participant's responses on their accurate trials (after excluding extreme outliers that were over 10 s), and then excluded individual response times that were more than two standard deviations beyond each participant's own mean (Ratcliff, 1993). We then removed any remaining response times that were under 200 ms, given that this amount of time is the minimum required for perceiving and responding to the stimulus (e.g., Cooper, Bandelow, & Nevill, 2011). Finally, we log transformed the remaining response times. This procedure excluded 4.69% of Stroop trials and brought the distribution of response times closer to the normal distribution, reducing skewness from 8.97 to 0.65, and kurtosis from 150.29 to 3.45. We analyzed the Stroop data using hierarchical linear modeling (HLM; Raudenbush & Bryk, 2002), treating individual trials (Level 1) as nested within participants (Level 2). To ensure that the model converged, Level 1 slopes were treated as fixed at Level 2 (Raudenbush & Bryk, 2002). The log-transformed response time on each Stroop trial was the dependent measure.

In the preliminary analysis, we ran 3 two-level HLMs with trial-level log-transformed response time as the dependent measure, and trial incongruence (0 = congruent, 1 = incongruent; Level 1), one of the demographic variables (gender, age, or SES; Level 2), and their interaction as predictors. None of the demographic variables interacted with trial incongruence, p 's > .22, and thus were not included in the primary analysis.

In the primary analysis, we ran an HLM with response time as the dependent variable and trial incongruence (0 = congruent, 1 = incongruent; Level 1) and condition (0 = nonstrenuous, 1 = strenuous; Level 2) as predictors, along with their interaction. The simple effect of trial incongruence was significant, $B = .132$, $SE = .016$, $z = 8.09$, $p < .001$, indicating that participants were slower on incongruent trials than on congruent trials, the standard Stroop incongruence effect. The simple effect of condition was nonsignificant, $B = .044$, $SE = .070$, $z = 0.64$, $p = .53$. As predicted, the Condition × Incongruence interaction was significant, $B = -.055$,

$SE = .023$, $z = 2.36$, $p = .018$.³ The negative sign of the interaction term indicates that the Stroop incongruence effect was *smaller* in the strenuous condition than in the nonstrenuous condition.

Study 1b Method

Participants. Fifty-seven undergraduates (34 women, 23 men; mean age 20.39 years; 47 with and 10 without at least one parent with a college degree) at the M. S. Ramaiah Institute of Technology in Bangalore, India, participated in the study. Participants were randomly assigned to either the strenuous or the nonstrenuous conditions. The study was conducted in English, given that English was the language of instruction at the university.

Manipulation. Participants first completed either an easy or a difficult version of the Stroop task. In the nonstrenuous condition, participants received 48 congruent Stroop trials, in which the meaning of the word and the color of the word were the same. In the strenuous condition, participants received 48 incongruent Stroop trials, in which the meaning of the word and the color of the word were always different.

Dependent measure. Thereafter, participants were instructed on the computer to remove a sheet of paper from a folder kept on the table, which included a word search puzzle task. The sheet contained a 15×15 table of letters along with a list of 28 words that appeared in the table (either horizontally, vertically, or diagonally). Participants were instructed to find as many words in the puzzle as they could in 8 min. The computer alerted participants once 8 min were over and asked them to proceed to the demographics section.

Study 1b Results

Seven participants with accuracy of less than 80% on the Stroop task were excluded from the analysis. The number of words that participants identified in the word search puzzle served as the dependent measure. Given that the dependent measure is a count variable, we ran three separate Poisson regressions to test whether participants' gender, age, and SES independently predicted performance on the word search task. Gender was not a significant predictor, $p = .34$, but older participants performed worse, $p = .001$, whereas higher SES participants performed better, $p = .025$. Therefore, we controlled for age and SES in the following analyses.

We ran a Poisson regression with number of words identified in the word search task as the dependent measure, and condition (0 = nonstrenuous, 1 = strenuous), age, and SES (centered) as the predictor variables. We found a significant effect of condition, $B = 0.17$, $z = 1.97$, $p = .049$, indicating that after working on the strenuous Stroop task, participants identified more words in the word search puzzle task, (estimated marginal means in log units: $\ln(M_{strenuous}) = 2.47$, $SE = .59$, in raw units: $M_{strenuous} = 11.82$), than after working on the nonstrenuous Stroop task (estimated marginal means in log units: $\ln(M_{nonstrenuous}) = 2.30$, $SE = .64$, in raw units: $M_{nonstrenuous} = 9.97$), replicating the reverse ego-depletion effect.

Study 1c Method

Participants. A survey seeking 500 India residents was posted on Amazon Mechanical Turk. In response, 510 participants completed the study. Of these, we excluded 45 participants who were not citizens of India or did not provide this information, leading to a final sample of 465 participants (116 women, 349 men; mean age 30.85 years; 411 with a college degree, 54 without). Participants were randomly assigned to the nonstrenuous condition or the strenuous condition. In total, 890 participants started the study. A logistic regression found that their likelihood of completing the study did not vary based on the experimental condition that they were randomly assigned to, $B = .037$, $SE = .14$, $z = .27$, $p = .79$, indicating that the results are not confounded by more participants dropping out from the strenuous condition than the nonstrenuous condition (Zhou & Fishbach, 2016).

Manipulation. We used a manipulation of attention control, which has been employed in nearly two-dozen ego-depletion studies (see Hagger et al., 2010, Appendix A, pp. 1–2). Participants were shown a 6-min silent video of a woman being interviewed by an off-camera interviewer. Below the video, a number of unrelated words were shown for 30 s each (see Schmeichel, Vohs, & Baumeister, 2003, Study 1, for additional details). In the *non-strenuous condition*, participants were informed “Just watch the video as you would normally do, as if you were sitting at home watching television.” However, those in the strenuous condition were instructed “Please do not read or look at any of the words that appear on the screen. If you find yourself looking at the words, please redirect your gaze to the woman being interviewed.”

Dependent measure. To assess participant's cognitive performance following previous self-control exertion we used the digit-symbol substitution task, which is a subset of the Wechsler Adult Intelligence Scale (WAIS-R; Wechsler, 1981) and measures processing speed. Participants were shown a table containing nine symbols matched with digits ranging from 1 to 9, and then given a practice trial. In the main task, participants were shown a table containing 93 symbols, with a legend displaying the digit-symbol pairing on the top of the screen. Participants were asked to successively type the digit matching each symbol in order. They could not go back if they made a mistake. This task was timed for 2 min. The dependent measure was the number of symbols for which participants entered the correct digit.

Results

We first tested whether each of the demographic variables (gender, age, and SES) was independently associated with participants' performance. As the dependent variable was a count variable (number of correctly matched digit-symbol pairings within a fixed duration), we analyzed the data using a Poisson regression. We found that men performed better than women, $B = .034$, $SE = .017$, $z = 2.05$, $p = .041$, younger participants performed better than older participants, $B = -.0049$, $SE = .00085$, $z = 5.77$, $p < .001$, and higher SES participants performed worse, $B = -.11$, $SE = .021$, $z = 4.97$, $p < .001$. Therefore, we controlled for participants' gender, age, and SES in the subsequent analyses.

³ The interaction effect remains significant even when Level 1 slopes are treated as randomly varying at Level 2, $p = .046$.

We ran a Poisson regression with number of correctly solved digit-symbol substitutions as the dependent measure, and condition (0 = nonstrenuous, 1 = strenuous), along with the demographic covariates, which were centered around their respective means. We found a significant effect of condition, $B = 0.031$, $SE = .014$, $incidence\ rate\ ratio = 1.03$, $z = 2.15$, $p = .031$, indicating that after working on the strenuous Stroop task, participants solved more digit-symbol substitutions correctly (estimated marginal means in log units: $\ln(M_{strenuous}) = 3.76$, $SE = .010$, in raw units: $M_{strenuous} = 43.08$), than after working on the nonstrenuous Stroop task (estimated marginal means in log units: $\ln(M_{nonstrenuous}) = 3.73$, $SE = .010$, in raw units: $M_{nonstrenuous} = 41.78$), replicating the reverse ego-depletion effect.

Discussion

Studies 1a, 1b, and 1c provided support for our central hypothesis that people from the Indian cultural context would exhibit a reverse ego-depletion effect. After completing strenuous, nearly impossible mazes, compared with nonstrenuous, easily solvable mazes, Indian participants exhibited *better* cognitive control on the Stroop task. Further, after completing a strenuous version of the Stroop task rather than a nonstrenuous version, our Indian participants performed *better* on a subsequent word search task. Finally, after controlling their attention while viewing a silent video, Indian participants performed better on the digit-symbol substitution task, a component of the Wechsler Adult Intelligence Scale, than after viewing the video without controlling their attention. The effect sizes tended to be small but were in the opposite direction as that expected by the strength model of small control.

Studies 1a to 1c thus demonstrated a new phenomenon: In a cultural context in which individuals tend to believe that exerting willpower is energizing, people exhibit the reverse ego-depletion effect. Although previous research has identified conditions under which the ego-depletion effect does not occur (Clarkson et al., 2010; Job et al., 2010; Schmeichel & Vohs, 2009; Tice et al., 2007; Wan & Sternthal, 2008), to our knowledge, this is the first demonstration that finds exactly the opposite of the ego-depletion phenomenon in the standard dual task paradigm.

One limitation of Studies 1a, 1b, and 1c is that they only included Indian participants, without also sampling Westerners. Given questions about the reliability and replicability of the ego-depletion effect (Carter et al., 2015; Hagger et al., 2016), it is unclear whether Westerners would exhibit ego-depletion, reverse ego-depletion, or a null effect on the same tasks. Therefore, Studies 2 and 3 tested whether the reverse ego-depletion effect observed with Indian participants would generalize to a Western cultural context.

Study 2

Study 2 recruited participants from India and U.S. The aim was to test whether the reverse ego-depletion effect observed with Indian participants in Studies 1a to 1c is specific to Indian culture or would also occur in a U.S. sample. We predicted that only Indian participants would show the reverse ego-depletion effect.

Method

Participants. Surveys seeking 200 residents of India and 200 residents of the U.S. were posted on Amazon Mechanical Turk. In response, 185 Indians and 195 Americans completed the study. Of these, we excluded seven participants who were not citizens of their respective countries, leading to a final sample of 180 Indians (63 women, 115 men, two unreported; mean age 30.88 years; 167 with a college degree, 13 without) and 193 Americans (123 women, 70 men; mean age 38.27 years; 95 with a college degree, 98 without). Participants were randomly assigned to either the strenuous condition or the nonstrenuous condition. In total, 1306 participants started the study. A logistic regression found that participants' likelihood of completing the study did not vary based on the experimental condition that they were randomly assigned to, $B = .27$, $SE = .74$, $z = .36$, $p = .72$, indicating that the results are not confounded by more participants dropping out from the strenuous condition than the nonstrenuous condition (Zhou & Fishbach, 2016).

Manipulation. Participants in the nonstrenuous condition were presented with an image of a page taken from a dense scientific text and asked to type out the text in a box. They had to type two such pages, each timed for 5 min. In the strenuous condition, participants were presented with the same scientific texts but were given additional instructions: In the first block, they were asked to type out the text while leaving out all instances of the letter *e*, and in the second block, they were asked to type out the text while leaving out all instances of the letter *e* except when another vowel followed the *e* in the same word (e.g., "need" or "read") or when a vowel was one letter removed from the letter *e* in either direction in the same word (e.g., "vowel"). Both the scientific text to be typed out and the instructions in the strenuous condition were taken from past ego-depletion research and have been used in over two-dozen ego-depletion studies (see Hagger et al., 2010, Appendix A, p. 1). An examination of participants' responses to the two typing tasks used in the manipulation revealed that 16 participants failed to follow the instructions (e.g., leaving the box for typing the paragraph blank; typing out the survey web site URL; or providing bogus responses, such as "this passage to some procedure to follow all study"). These participants were excluded from the analysis.

Manipulation check. After participants completed the typing task, we administered a manipulation check to test whether participants in the strenuous condition actually found the typing task more strenuous than those in the nonstrenuous condition. Participants were asked "How difficult was the task?," "How much did you have to concentrate during the task?," and "How exhausting was the task?" and asked to respond on 7-point scales ranging from *not at all* to *extremely*.

Dependent measure. The dependent measure was the modified Stroop task, which was similar to the task in Study 1a with a few changes: (a) we included a total of 120 trials, 40 congruent, 40 incongruent, and 40 neutral ("XXX" written in one of the four colors); (b) the legend specifying which button had to be pressed for which color was not displayed; and (c) the color black was used instead of yellow.

Analysis

Sixty-one participants whose average accuracy was less than 80%, indicating that they were not responding sincerely, were removed from the analysis. We used the same procedure as in Study 1 for cleaning and transforming the Stroop response time data. This procedure brought the distribution of response times closer to the normal distribution, reducing skewness from 23.15 to 0.54, and kurtosis from 1563.11 to 3.07.

Results

Manipulation check. We averaged participants' responses to the three items assessing how strenuous the initial task was, $\alpha = .69$, and submitted it to a 2 (Culture) \times 2 (Condition) ANOVA. We found the predicted main effect of condition, $F(1, 297) = 15.33, p < .001$, indicating that participants found the task more strenuous in the strenuous condition ($M = 5.18, SE = .137$) than in the nonstrenuous condition ($M = 4.47, SE = .136$). The main effect of culture and the Culture \times Condition interaction were nonsignificant, p 's $> .15$, indicating that the experimental manipulation was similarly experienced by the two cultural groups.

Stroop effect—Preliminary analyses. In the preliminary analysis, we ran 3 two-level HLMs with the log-transformed response time on each Stroop trial as the dependent measure. In these initial analyses, we included trial incongruence (Level 1), one of the demographic variables (gender, age, or SES; Level 2), and their interaction as predictors in three separate models. We found significant interactions between trial incongruence and the demographic variables: Men showed a smaller Stroop effect than women ($p = .001$), older people showed a larger Stroop effect than younger people ($p = .011$), and people with a college degree showed a smaller Stroop effect than those without one ($p = .001$). Thus, we included gender, age, and SES, along with their interactions with trial incongruence, as control variables in the following analyses.

Stroop effect—Primary analyses. We ran an HLM with trial incongruence (i.e., 1 = color and meaning incongruent, 0 = not incongruent; Level 1), strenuous condition (0 = nonstrenuous, 1 = strenuous; Level 2), and culture (0 = Americans, 1 = Indians; Level 2), all interactions between these variables, and the demographic covariates noted above as predictor variables.

The simple effect of trial incongruence was significant, $B = .17, SE = .009, z = 18.06, p < .001$, indicating that participants were slower on incongruent trials compared with the remaining trials, the standard Stroop incongruence effect. We found a simple effect of culture, $B = .15, SE = .039, z = 3.96, p < .001$, indicating that Indians were overall slower than Americans. The simple effect of condition was nonsignificant, $B = -.027, SE = .034, z = 0.79, p = .43$. The Culture \times Condition interaction was also nonsignificant, $B = .024, SE = .049, z = 0.49, p = .63$. There was a significant Culture \times Incongruence interaction, $B = -.042, SE = .014, z = 3.02, p = .002$, indicating that Indians showed a smaller Stroop effect than Americans. There was a Condition \times Incongruence interaction, $B = .023, SE = .012, z = 1.92, p = .055$, indicating that the Stroop effect was larger in the strenuous condition than in the nonstrenuous condition. Finally, all these effects were qualified by a three-way Culture \times Condition \times Incongruence interaction, $B = -.051, SE = .018, z = 2.89, p = .004$.⁴ The interactions between trial incongruence and gender, age, and SES

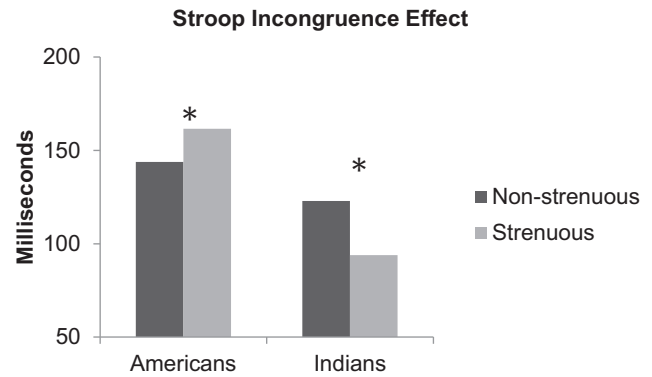


Figure 1. Stroop incongruence effect (difference in response times between incongruent trials and congruent trials, computed after converting model-estimated response times for congruent and incongruent trials from log milliseconds into milliseconds), by culture and condition (Study 2). * $p \leq .05$.

were no longer significant, p 's $> .11$, and thus dropped from the following within-culture analyses. The significance levels of all the above effects remain unchanged if the demographic variables are dropped from the model.

Stroop effect—Follow-up analysis. To decompose the three-way interaction, we ran separate HLM models by culture with trial incongruence, condition, and their interaction as predictors. For Indians, we again found a main effect of incongruent trials, $B = .12, SE = .009, z = 13.58, p < .001$, and a Condition \times Incongruence interaction, $B = -.027, SE = .014, z = 1.99, p = .047$. The negative coefficient of the interaction term indicates that the Stroop incongruence effect was *smaller* in the strenuous condition than in the nonstrenuous condition (see Figure 1). Thus, we found evidence for a reverse ego-depletion effect with Indian participants—after working on a strenuous typing task initially, participants were *better* at exerting self-control in the subsequent Stroop task.

For Americans, we found a main effect of trial incongruence, $B = .17, SE = .008, z = 21.27, p < .001$, and a Condition \times incongruence interaction, $B = .022, SE = .011, z = 1.95, p = .051$. The positive coefficient of the interaction term indicates that the Stroop incongruence effect was *larger* in the strenuous condition than in the nonstrenuous condition (see Figure 1). Thus, we found the standard ego-depletion effect in the U.S.—after working on a strenuous typing task initially, participants were *worse* at exerting self-control in the subsequent Stroop task.

Discussion

Study 2 indicated that the reverse ego-depletion effect observed with Indian participants in Studies 1a to 1c did not generalize to the U.S. participants. In the current study, whereas Indians exhibited a reverse ego-depletion effect, Americans exhibited the standard ego-depletion effect on the same set of tasks. After completing a strenuous typing task, compared with a nonstrenuous task,

⁴ The three-way interaction effect remains significant even when Level 1 slopes are treated as randomly varying at Level 2, $p = .032$.

Indian participants exhibited *better* cognitive control on the Stroop task whereas American participants exhibited *worse* cognitive control on the Stroop task. This asymmetry occurred despite the fact that both groups found the strenuous task more difficult and exhausting than the nonstrenuous task. The pattern of performance exhibited in each culture matched the lay beliefs identified in the pilot study—Americans' belief that exerting willpower is depleting versus Indians' belief that exerting willpower is energizing.

One incidental finding was that Americans exhibited an overall stronger Stroop effect than Indian participants. One possible explanation for this finding is that English was probably the first language for the vast majority of American participants but the second language for the vast majority of Indian participants. There is research showing that people exhibit a stronger Stroop effect in their first language than in their second language (Altarriba & Mathis, 1997). As our focus is on the differences in the Stroop effect across experimental conditions within the same cultural group, cultural differences in the mean Stroop level cannot act as a confounding variable.

Study 3

The goal of Study 3 was to provide yet another test of the key finding in Study 2, that the reverse ego-depletion effect observed with Indian participants does not generalize with Western participants using different tasks and using participants from another Western country. We used the commonly used attention control task in the experimental manipulation of this study, followed by the Stroop task as the dependent measure. In addition, Study 3 tested the proposed mechanism explaining why Indians exhibit reverse ego-depletion. Following our assumption that Indians exhibit the reverse ego-depletion effect because of their beliefs about willpower, we tested whether lay beliefs about willpower predict the reverse ego-depletion effect observed among Indian participants.

Method

Participants. A total of 143 students were run in the lab: 59 participants (22 women, 37 men; mean age 21.19 years; 39 with and 20 without at least one college educated parent) at the M. S. Ramaiah University in Bangalore, India, and 84 participants (58 women, 26 men; mean age 23.74; 65 with and 19 without at least one college-educated parent) at the University of Zurich, Switzerland. Participants were randomly assigned to either the strenuous condition or the nonstrenuous condition. In total, 1306 participants started the study. Indian participants were provided with instructions in English given that English was the language of instruction at the university, and Swiss participants were provided with instructions in German given that German was the language of instruction at the university.

Instruction check. Given that the experimental manipulation in this study was implemented using a single instruction page, we included an instruction check task (Oppenheimer, Meyvis, & Davidenko, 2009) prior to random assignment. Participants were presented with a long paragraph that, among other irrelevant information, stated "So, in order to demonstrate that you have read the instructions, please do not select any of the recreation option mentioned below. Instead, simply click on the last available option

to proceed to the next screen." Below the instructions, participants were asked "How do you spend your free time? Please select the activity that you engage in most" followed by a list of activities and a "None of the above" option. If participants failed to select "None of the above," the same screen was shown again up to a maximum of 10 times with the goal of encouraging participants to read the instructions (see Oppenheimer et al., 2009, Study 2). Five participants (one Indian and four Swiss) who failed to follow the instructions 10 or more times were excluded from the analysis.

Manipulation. We used a similar experimental manipulation as in Study 1c. Participants were asked to watch a silent 6-min video of a woman being interviewed, with random words intermittently flashing below the video. Those in the nonstrenuous condition were not provided with additional instructions. Those in the strenuous condition were instructed "Please do not read or look at any of the words that appear on the screen. If you find yourself looking at the words, please redirect your gaze to the woman being interviewed."

Dependent measure. After the attention control task, participants were asked to complete a modified Stroop task, which was similar to the one used in Study 1a with the exception that the total number of trials was increased and the proportion of incongruent trials was decreased to make the task more difficult (Logan & Zbrodoff, 1979). Of the 120 trials total, 96 were congruent and 24 were incongruent.

Beliefs about willpower. After the Stroop task, participants were presented with the same four items used in the pilot study to assess whether they believed that exerting willpower is depleting (i.e., working on an initial strenuous task would worsen their performance on a subsequent strenuous task) or that exerting willpower is energizing (i.e., working on an initial strenuous task would improve their performance on a subsequent strenuous task).

Results

Five participants (three Indians and two Swiss) with accuracy of less than 80% on the Stroop task were excluded from the analysis.

Beliefs about willpower. We averaged the four items measuring participants' beliefs about willpower ($\alpha = .60$). A *t* test found that Indians ($M = 10.55$, $SD = 3.67$) were more likely than the Swiss ($M = 8.37$, $SD = 3.85$) to believe that exerting willpower is energizing, $t(131) = 3.29$, $p = .001$, Cohen's $d = .58$, 95% CI $[-.22, -.93]$.

Stroop effect—Preliminary analysis. We used the same procedure as in Study 1 for cleaning the Stroop data. In the preliminary analysis, we ran three 2-level HLMs with trial-level log transferred response time as the dependent measure, and trial incongruence (0 = congruent, 1 = incongruent; Level 1), one of the demographic variables (gender, age, or SES; Level 2), and their interaction as predictors. Gender did not predict the Stroop incongruence effect, $p = .50$, but age, $p = .017$, and SES, $p = .020$, were significant predictors. Thus, we included age and SES as covariates in the primary analyses.

Stroop effect—Primary analyses. We ran a two-level HLM with response time as the dependent variable and trial incongruence (0 = congruent, 1 = incongruent; Level 1), culture (0 = Swiss, 1 = Indian; Level 2), and condition (0 = nonstrenuous, 1 = strenuous; Level 2) as predictors, along with all interactions between these variables. Age and SES, and each of their interaction

with trial incongruence, were included as covariates. The simple effect of trial incongruence was significant, $B = .12$, $SE = .009$, $z = 13.80$, $p < .001$, indicating that participants were slower on incongruent trials compared with the remaining trials, the standard Stroop incongruence effect. We found a simple effect of culture, $B = .21$, $SE = .040$, $z = 5.19$, $p < .001$, indicating that Indians were overall slower than the Swiss. The simple effect of condition was nonsignificant, $B = .057$, $SE = .035$, $z = 1.62$, $p = .11$. The Culture \times Condition interaction was also nonsignificant, $B = -.024$, $SE = .055$, $z = 0.43$, $p = .67$. There was a significant Culture \times Incongruence interaction, $B = .13$, $SE = .014$, $z = 8.77$, $p < .001$, indicating that Indians showed a larger Stroop effect than the Swiss. There was a Condition \times Incongruence interaction, $B = .034$, $SE = .012$, $z = 2.73$, $p = .006$, indicating that the Stroop effect was larger in the strenuous condition than in the nonstrenuous condition. Finally, all these effects were qualified by a three-way Culture \times Condition \times Incongruence interaction, $B = -.080$, $SE = .019$, $z = 4.10$, $p < .001$.⁵

Stroop effect—Follow-up analysis. To investigate this three-way interaction, we conducted separate HLMs within each culture. Among Indian participants, the simple effect of trial incongruence was significant, $B = .24$, $SE = .014$, $z = 17.58$, $p < .001$. The simple effect of condition was nonsignificant, $B = .030$, $SE = .039$, $z = 0.78$, $p = .44$. As predicted, the Condition \times Incongruence interaction was significant, $B = -.046$, $SE = .015$, $z = 3.04$, $p = .002$. The negative sign of the interaction term indicates that the Stroop incongruence effect was *weaker* in the strenuous condition than in the nonstrenuous condition among Indian participants (see Figure 2).

Among Swiss participants, the simple effect of trial incongruence was significant, $B = .12$, $SE = .0086$, $z = 13.89$, $p < .001$. The simple effect of condition was nonsignificant, $B = .059$, $SE = .036$, $z = 1.63$, $p = .10$. The Condition \times Incongruence interaction was significant, $B = .034$, $SE = .012$, $z = 2.77$, $p = .006$. The positive sign of the interaction term indicates that the Stroop incongruence effect was *stronger* in the strenuous condition than in the nonstrenuous condition among Swiss participants (see Figure 2).

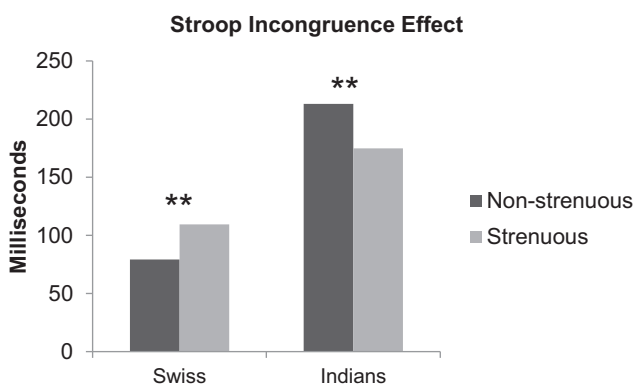


Figure 2. Stroop incongruence effect (difference in response times between incongruent trials and congruent trials, computed after converting model-estimated response times for congruent and incongruent trials from log milliseconds into milliseconds), by culture and condition (Study 3). ** $p \leq .01$.

Effect of willpower beliefs. We next tested whether participants' beliefs about willpower influenced the pattern of their ego-depletion effect in Switzerland and in India. We ran separately HLMs by culture, with participants' Stroop response time as the dependent measure, and their willpower belief (centered, with higher numbers indicating the belief that exerting willpower is energizing), condition, and trial congruence, as the predictors. Among Swiss participants, the three-way interaction between Condition \times Incongruence \times Willpower Belief was not significant, $p = .87$. Among Indian participants, however, we found a significant three-way interaction, $B = -.0088$, $SE = .0044$, $z = 2.00$, $p = .045$. We conducted follow-up spotlight analyses to disentangle this three-way interaction. At one standard deviation below the mean on willpower beliefs (i.e., individuals who tend to believe that exerting willpower is depleting), the interaction between the strenuous versus nonstrenuous manipulation and trial incongruence was nonsignificant, $B = -.010$, $SE = .022$, $z = 0.46$, $p = .65$, indicating that Indians who believe that exerting willpower is depleting do not exhibit the reverse ego-depletion effect (see Figure 3). In contrast, at one standard deviation above the mean on willpower beliefs (individuals who tend to believe that exerting willpower is energizing), the interaction between the strenuous versus nonstrenuous task manipulation and trial incongruence was highly significant, $B = -.075$, $SE = .023$, $z = 3.32$, $p = .001$, indicating that Indians who believe that exerting willpower is energizing exhibit the reverse ego-depletion effect (see Figure 3).

Discussion

Study 3 replicated the findings from previous studies that Indians exhibit a reverse ego-depletion effect. Further, Study 3 replicated Study 2's finding that Westerners exhibit the standard ego-depletion effect using another combination of tasks and in another Western country. Specifically, Indians performed better but Swiss performed worse on the Stroop task after controlling their visual attention compared with when they were not asked to control their attention.

Study 3 did not include a manipulation check because we did not want the presence of manipulation check questions to alter the link between the initial strenuous versus nonstrenuous task and subsequent performance. However, we acknowledge that without a manipulation check, it is not clear whether Indian and Swiss participants experienced the manipulation as equally demanding. If Indian versus Swiss participants differed in how exhausting they experienced the initial task, this could explain the differences between the subsequent performance of the two groups. Notably, Study 2 did include a manipulation check and found that participants from both cultures in the strenuous condition found the initial task similarly exhausting compared to those in the non-strenuous condition.

Study 3 identified a potential mechanism underlying the reverse ego-depletion effect found with Indian participants but not with Swiss participants. Indians who tended to believe that exerting willpower is energizing, that exerting self-control facilitates performance on subsequent strenuous tasks, demonstrated the reverse ego-depletion effect most strongly. Indians who tended to believe

⁵ The three-way interaction remains significant even when Level 1 slopes are treated as randomly varying at Level 2, $p = .028$.

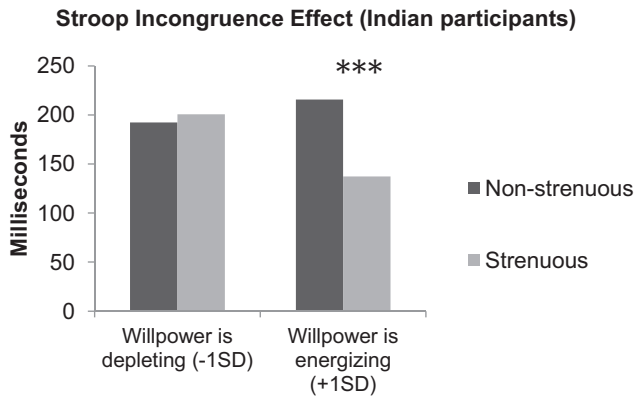


Figure 3. Stroop incongruence effect (difference in response time between incongruent trials and congruent trials, computed after converting model-estimated response times for congruent and incongruent trials from log milliseconds into milliseconds), by condition and beliefs about willpower among Indian participants (Study 3). *** $p \leq .001$.

that exerting willpower is depleting, that exerting self-control on strenuous tasks would hurt performance on subsequent strenuous tasks, were the ones who did not benefit from previous self-control exertion. However, it is possible that the energizing belief does not exert a causal effect on Indians' performance following strenuous tasks, but instead Indians learned this belief based on self-observation, as might be predicted by self-perception theory (Bem, 1967). Accordingly, the cultural difference in the ego-depletion pattern could be caused by factors unrelated to lay beliefs, and cultural differences in lay beliefs might simply reflect the different depletion patterns. Therefore, Study 4 manipulated lay beliefs about willpower to test their causal effect on reversed ego-depletion.

Study 3's findings did not support the idea that our measure of lay beliefs about whether exerting willpower is depleting versus energizing are equally predictive across cultural contexts, as these beliefs did not predict the extent of ego-depletion among Swiss participants. This result suggests the possibility that the energizing belief, as presently assessed, might not be a valid predictor of ego-depletion in a context in which the belief is not as culturally grounded. Previous research has found that the belief in self-control as a limited versus a nonlimited resource predicts whether Americans show ego-depletion or not (Job et al., 2010). Hence, in a cultural context in which the depleting belief is more prevalent, the extent to which people adopt the depleting belief predicts their extent of ego-depletion. Here, we found that in a cultural context in which the energizing belief is more prevalent, the extent to which people adopt the energizing belief predicts the extent of reversed ego-depletion. The next question that arises is: Can people from a Western context be induced to adopt an energizing belief? Would learning about the possibly energizing effect of self-control exertion make people from a Western cultural context also exhibit the reversed ego-depletion pattern? We address this question in Study 4.

Study 4

The goal of Study 4 was to test whether lay beliefs about willpower exert a causal effect on the reverse ego-depletion effect.

We tested this idea using the *experimental causal chain* design (Spencer, Zanna, & Fong, 2005). Specifically, the pilot study has already demonstrated the independent variable (culture) to the mediator (lay beliefs about willpower) effect. In Study 4, we assess the mediator to the dependent variable (reverse ego-depletion) effect in both Indian and Western cultures by experimentally manipulating the mediator. This approach presents the strongest method for testing mediating mechanisms (Spencer et al., 2005).

Method

Participants. Surveys seeking 400 residents of India and 400 residents of the U.S. were posted on Amazon Mechanical Turk. In response, 400 participants from each culture submitted the HIT on Mechanical Turk but only 383 Indians and 382 Americans completed the study. Of these, we excluded four participants who were not citizens of India and nine participants who were not citizens of the U.S., leading to a final sample of 379 Indians (139 women, 240 men; mean age 38.29 years; 312 with a college degree, 67 without) and 373 Americans (225 women, 148 men; mean age 35.84 years; 196 with a college degree, 177 without). Participants were randomly assigned to one cell of a 2 (Belief: Depleting vs. Energizing) \times 2 (Task: Nonstrenuous vs. Strenuous) design.

In total, 1135 participants started the study. A logistic regression found that the chances of the 1,135 participants who were randomly assigned to either the depleting belief or the energizing belief condition dropping from the study did not differ by condition, $B = .013$, $SE = .13$, $z = .11$, $p = .92$. Another logistic regression found that the chances of the 1,011 participants who were randomly assigned to either the strenuous condition or the nonstrenuous condition dropping from the study did not differ by condition, $B = .12$, $SE = .15$, $z = .82$, $p = .41$. Therefore, the results are not contaminated by more participants dropping out from either the energizing belief versus the depleting belief condition, or the strenuous versus the nonstrenuous condition (Zhou & Fishbach, 2016).

Beliefs about willpower manipulation. To manipulate beliefs about willpower, we asked participants to read a "research article" about concentration. Participants were informed "Please read the article very carefully because you will be asked a series of comprehension questions about this article later on." We created two articles, one arguing that exerting willpower is depleting and the other arguing that exerting willpower is energizing (see Appendix A and B). Both articles contained a total of 600 words and were divided into seven paragraphs, each with a heading and displayed on a separate page to increase readability (the article title was displayed on each page). Each paragraph was displayed on the screen for a minimum of 10 s to ensure that participants cannot just click through the screens. To maintain consistency with the cover story, once participants finished reading the article, they were presented with five true-false questions about the article, four of which differed across conditions and conveyed the main point of the article.

External manipulation check. We conducted an external manipulation check to verify whether the manipulation that we devised successfully influenced the targeted lay theories about willpower without influencing nontargeted constructs. In particular, we tested whether our manipulation influenced participants' beliefs about the utility of effort (Heine et al., 2001). Specifically,

it is likely that people experience working on strenuous tasks, on which it is difficult to perform well, as a failure. In contrast, they may experience working on nonstrenuous tasks, on which it is easy to perform well, as a success. If like Japanese, Indians believe in the utility of effort (Heine et al., 2001), they might try to counter a failure experience by exerting more effort in and performing better on a subsequent task. In contrast, if Americans do not believe in the utility of effort (Heine et al., 2001), they might disengage following a failure experience, thus exerting less effort in and performing worse on a subsequent task. Therefore, it is possible that people's beliefs about the utility of effort, not their lay theories about willpower, are the causal mechanism. We thus conducted an external manipulation check to ensure that our manipulation influenced people's lay theories about willpower but not their beliefs about the utility of effort.

Surveys seeking 100 Indian and 100 American participants were posted on Amazon Mechanical Turn. In response, 206 participants (104 Indians and 102 Americans) completed the survey. Of these, we excluded seven participants who were not citizens of their respective countries, yielding a final sample of 100 Indians (24 women, 76 men; mean age 29.14 years; 63 without and 37 with a college degree) and 99 Americans (59 women, 40 men; mean age 35.68 years; 89 without and 10 with a college degree).

Participants were presented with either the article claiming that exerting willpower is energizing, or the article claiming that exerting willpower is depleting. Thereafter, participants were presented with the four-item measure of lay theories about willpower used in Study 3, $\alpha = .81$, and a four-item measure about the utility of effort from Heine et al. (2001, Table 3), $\alpha = .65$.⁶

Upon submitting participants' lay theories about willpower to a 2 (Culture) \times 2 (Condition) ANOVA, we found a main effect of condition, $F(1, 195) = 57.35, p < .001$, indicating that participants exposed to the article proclaiming that exerting willpower is energizing were more likely to hold the energizing belief, $M = 12.26, SD = 4.11$, than those exposed to the article claiming that exerting willpower is depleting, $M = 7.46, SD = 4.71$. Further, replicating the pilot study's findings, we found a main effect of culture, $F(1, 195) = 7.89, p = .006$, indicating that overall, Indians held the energizing belief, $M = 10.86, SD = 4.99$, more than Americans, $M = 8.82, SD = 4.86$. The Culture \times Condition interaction was nonsignificant, $F(1, 195) = .01, p = .93$.

Upon submitting participants' belief in the utility of effort to a 2 (Culture) \times 2 (Condition) ANOVA, we found a marginal main effect of culture, $F(1, 195) = 3.30, p = .071$, indicating that overall, Indians believed in the utility of effort, $M = .63, SD = .13$, more than Americans, $M = .59, SD = .13$. Importantly, there was neither a main effect of condition, $F(1, 195) = .18, p = .67$, nor a Culture \times Condition interaction, $F(1, 195) = .00, p = .97$. The marginal main effect of culture is consistent with past research showing that Indians are more likely than Americans to believe that intelligence can be increased over time (Rattan et al., 2012), and also consistent with Heine et al.'s (2001) finding that Japanese are more likely to believe in the utility of effort than Americans.

The external manipulation check thus confirmed that the articles similarly influenced both Indian and American participants' lay theories about willpower but neither Indian nor American participants' beliefs about the utility of effort.

Strenuous task manipulation. After participants read the article either claiming that exerting willpower is depleting or that

exerting willpower is energizing, we administered the video manipulation used in Study 1c. Participants in the nonstrenuous condition were instructed "Just watch the video as you would normally do, as if you were sitting at home watching television." Those in the strenuous condition were instructed "While the video is playing, some words will be shown below the video. Please do not read or look at any of the words that appear on the screen. If you find yourself looking at the words, please redirect your gaze to the woman being interviewed."

Dependent measure. We used the dependent measure employed in Study 1c, the digit-symbol substitution task, which is a subset of the Wechsler Adult Intelligence Scale.

Results

Preliminary analyses. We first tested whether each of the demographic variables (gender, age, and SES) were independently associated with participants' performance. As the dependent variable was a count variable (number of correctly matched digit-symbol pairings within a fixed duration), we analyzed the data using a Poisson regression. We found that men performed worse than women, $B = -.12, SE = .011, z = 11.65, p < .001$; age was unrelated to participants' performance, $B = -.00013, SE = .000083, z = 1.59, p = .11$; and higher SES participants performed worse, $B = -.12, SE = .011, z = 10.43, p < .001$. Therefore, we controlled for participants' gender and SES in the subsequent analyses.

Effects of experimental manipulation. We ran a Poisson regression with culture ($-.5 =$ Americans, $+.5 =$ Indians), belief condition ($-.5 =$ depleting article, $+.5 =$ energizing article), and task condition ($-.5 =$ nonstrenuous, $+.5 =$ strenuous) as predictors, along with all interactions between these variables. We found main effects of culture, $B = -.064, SE = .011, z = 5.64, p < .001$; strenuous versus nonstrenuous task condition, $B = .053, SE = .011, z = 4.99, p < .001$; and belief condition, $B = -.031, SE = .011, z = 2.94, p = .003$. We also found three two-way interactions: Culture \times Strenuous versus nonstrenuous task condition, $B = .048, SE = .021, z = 2.27, p = .023$; Culture \times Belief condition, $B = -.051, SE = .021, z = 2.37, p = .018$; and strenuous versus nonstrenuous task Condition \times Belief condition, $B = .062, SE = .021, z = 2.93, p = .003$. The three-way Culture \times Task Condition \times Belief Condition interaction was nonsignificant, $B = .038, SE = .043, z = .89, p = .38$.

Follow-up analyses. To investigate the pattern of the three two-way interactions, we ran separate Poisson regressions for each culture and belief condition, without any covariates. Among Indian participants in the depleting belief condition, participants' performance did not differ across the strenuous versus nonstrenuous conditions, $B = .034, SE = .022, z = 1.58, p = .115$. In the energizing belief condition, Indians exhibited a strong reverse ego-depletion effect, $B = .099, SE = .022, z = 4.52, p < .001$ (see Figure 4). Among American participants in the depleting belief

⁶ Only Items 1, 2, 3, and 5 from Heine et al.'s (2001) scale were included in the current study because the remaining items did not differ across American and Japanese cultures, contrary to the authors' predictions. As the four items were measured on different scales, each item's theoretical minimum-maximum was scaled to range from 0 to 1 before the four items were averaged.

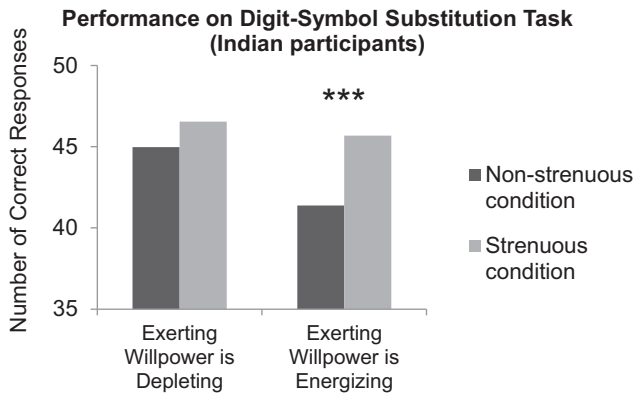


Figure 4. Indian participants' mean performance on the digit-symbol substitution task (unadjusted raw means), by belief condition and task condition (Study 4). *** $p \leq .001$.

condition, participants' performance did not differ across the strenuous versus nonstrenuous conditions, $B = .010$, $SE = .021$, $z = .50$, $p = .62$. However, in the energizing belief condition, Americans too exhibited a reverse ego-depletion effect, $B = .055$, $SE = .021$, $z = 2.64$, $p = .008$ (see Figure 5).

Discussion

Study 4 provided evidence that beliefs about willpower exert a causal impact on the reverse ego-depletion effect. Both Indian and American participants exposed to an article arguing that exerting willpower is energizing exhibited a reverse ego-depletion effect. However, the reverse ego-depletion effect was substantially weakened among both Indian and American participants who were exposed to an article arguing that exerting willpower is depleting. Notably, Americans exposed to the article claiming that exerting willpower is depleting did not exhibit the standard ego-depletion effect, a finding that might be taken as a failure to replicate the usual ego-depletion effect.

The belief condition by task condition interaction appears to be driven by participants in the energizing, nonstrenuous condition, who showed the worst performance. This pattern is consistent with previous research documenting that participants with a nonlimited belief about willpower tend to show particularly low performance following nonstrenuous tasks that do not require one to exert much self-control (Job et al., 2015). This result indicates that the reverse ego-depletion effect could in part be caused by the tendency of individuals with an energizing belief to engage less in subsequent tasks after completing a nonstrenuous task initially. Maybe the nonstrenuous task fails to provide them with a motivational boost that they need to gain momentum and maintain a high level of performance across multiple tasks.

The connection between the experimental manipulation of lay theories about willpower used in the current study, and performance on the subsequent tasks, might be transparent to participants, thus activating concerns about experimenter demand effects. The experimenter demand account would predict that participants exposed to the article claiming that exerting willpower is depleting would exhibit the ego-depletion effect, whereas those exposed to the article claiming that exerting willpower is energizing would

exhibit reverse ego-depletion. However, when presented with the article claiming that exerting willpower is depleting, neither Indian nor American participants exhibited ego-depletion, as would have been predicted by the experimenter demand account. Thus, demand effects are unlikely to be at play in the present study.

General Discussion

The present research showed that people in the Indian cultural context tend to believe that exerting willpower on one task can be energizing and can help them continue exerting self-control on subsequent tasks. This lay belief can become a self-fulfilling prophecy: Across a series of studies, Indian participants performed better on subsequent tasks requiring self-control after initially working on a strenuous task rather than a nonstrenuous task. This reverse ego-depletion effect with Indian participants was found with a range of tasks, including strenuous versus nonstrenuous versions of a verbal task (an online version of the e-crossing task), a spatial task (mazes), a cognitive control task (Stroop), and an attention control task. The effect was found with multiple measures of subsequent self-control performance, including the Stroop task, a word search task, and a digit-symbol substitution task that is a component of a standard IQ test. U.S. American and Swiss participants exhibited ego-depletion on two sets of tasks on which Indians exhibited reverse ego-depletion, but on a third set of tasks, American participants did not exhibit any ego-depletion effect. Finally, Indians who tended to believe, and Indians and Americans who were led to believe, that exerting willpower is energizing were more likely to perform better after strenuous tasks compared to nonstrenuous tasks, demonstrating the causal link between lay belief and the reverse ego-depletion effect.

Theoretical Implications

The present research contributes to a growing body of research documenting concerns with the strength model of self-control and its underlying assumption that self-control relies on a limited resource (Inzlicht & Schmeichel, 2012; Inzlicht et al., 2014; Molden et al., 2012). Whereas past research has revealed conditions under which the usual ego-depletion effect is not observed

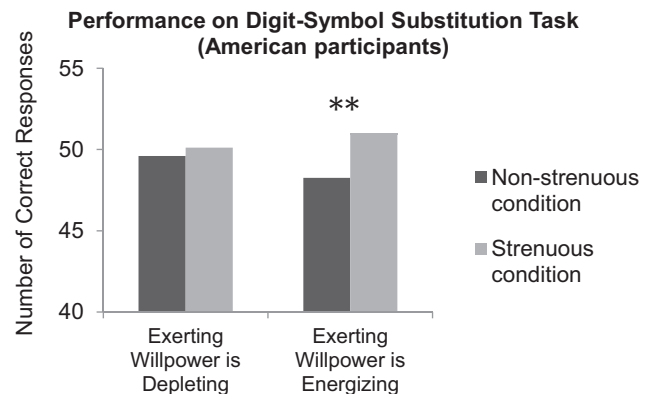


Figure 5. American participants' mean performance on the digit-symbol substitution task (unadjusted raw means), by belief condition and task condition (Study 4). ** $p \leq .01$.

(Job et al., 2010), the present research documents for the first time a population in which the usual ego-depletion effect is reversed even in the standard two unrelated tasks paradigm. This novel finding can be viewed as casting further doubt on claims that ego-depletion is a pan-cultural phenomenon rooted in human biology, and instead supports the argument that motivational factors play a crucial role in determining how strenuous tasks influence subsequent self-control exertion.

A few previous studies, however, have documented a reversal of the ego-depletion phenomenon by modifying the commonly used dual task paradigm. Specifically, when two tasks are related and require similar types of self-control (e.g., both tasks requiring spatial vigilance, both tasks requiring controlling food intake), exerting self-control on one task enhanced self-control on the second task (Converse, Pathak, Steinhauser, & Homan, 2012; Dewitte, Bruyneel, & Geyskens, 2009). Further, completing three strenuous tasks enhanced self-control on a subsequent task compared with completing one or two strenuous tasks (Converse & DeShon, 2009; Xiao, Dang, Mao, & Liljedahl, 2014; cf. Vohs et al., 2012). Working on an initial strenuous task for a short duration led to worse performance on a subsequent task compared with working on the same initial task for a longer duration (Dang, Dewitte, Mao, Xiao, & Shi, 2013). Taken together, these studies indicate that cognitive adaptation to strenuous tasks may eliminate or reverse the ego-depletion effect. In the present research, we showed that in Indian cultural contexts, in which people tend to believe that exerting willpower is energizing, the ego-depletion effect reverses even in the standard dual task paradigm, in which people work on two unrelated tasks one after another.

The present research contributes to the ongoing debate about the reliability and replicability of the ego-depletion effect (Carter et al., 2015; Hagger et al., 2016). Although to replicate the ego-depletion effect was not one of our goals, two of our studies found that U.S. and Swiss participants exhibited the ego-depletion effect, but one study found that Americans, even when exposed to the idea that exerting willpower is depleting, did not exhibit ego-depletion. These studies used different combinations of tasks, so it is possible that Westerners are more likely to exhibit ego-depletion with certain combination of tasks than with others. Taken together, our results are relatively representative of what we consider the current state of knowledge on the ego-depletion effect: It is not as robust as previously assumed, and more research is required to decide whether ego-depletion is a reliable and replicable finding. The current article is part of the next wave of research on ego-depletion, which focuses on factors that underlie and contribute to the occurrence of ego-depletion, no depletion, or even reverse ego-depletion.

Past research has identified one belief about willpower—whether people believe that willpower is limited or not limited—and documented consequences of this belief both for people's ability to exert self-control after strenuous versus nonstrenuous tasks (Job et al., 2010, 2015). Drawing on Indian philosophical traditions, the present research investigated a radical lay theory that has not been conceptualized previously, the idea that exerting willpower can even be energizing and that it can facilitate further self-control. Our studies show that people's patterns of self-control exertion match their personal beliefs and the beliefs prevalent in their culture, and that lay beliefs exert a causal effect on people's self-control capacity. The pilot study documented U.S.–India dif-

ferences in people's lay beliefs about willpower, and Study 4 documented that manipulating these lay beliefs influences people's extent of reverse ego-depletion in both the U.S. and in India. Thus, using the logic of the experimental causal chain (Spencer et al., 2005), we have established the link from the independent variable (culture) to the mediator (willpower theories), and from the mediator to the dependent variable (reverse ego-depletion), which held in both cultures. Thus, we can conclude that people's lay beliefs about willpower serve as a mediator for cultural differences in reverse ego-depletion. Moreover, the current research provides the first evidence that beliefs about willpower and their instantiation in reverse ego-depletion are shaped by people's cultural contexts.

Study 3 found that lay beliefs about willpower predicted the size of the reverse ego-depletion effect among Indian participants but not among Swiss participants. This finding suggests the possibility that the predictive validity of the lay beliefs, as assessed with our four-item measure, might be restricted to the cultural context in which they are grounded. This finding further highlights the cultural dependence both of the ego-depletion effect and of its underlying processes. Interestingly, our U.S. participants in Study 4 could adopt the energizing belief when it was presented to them in the form of a persuasive message. Therefore, despite the cultural roots of the energizing lay theory, it can be potentially induced by targeted interventions and influence people's behavior.

The present research highlights the shortcomings of drawing conclusions about the human species based on research largely conducted with samples from western, educated, industrialized, rich, and democratic societies (Henrich, Heine, & Norenzayan, 2010). Indeed, two recent meta-analyses including over 100 ego-depletion studies (Carter et al., 2015; Hagger et al., 2010) do not mention the word "culture" or even "country." This indicates that either there has been little research on ego-depletion outside North America and Europe, or that if research has been conducted in other parts of the world, researchers did not deem it important enough to note it in their meta-analyses. Indeed, advances in cultural psychology have demonstrated that many psychological phenomena thought to be fundamental to the human species are instead culturally rooted (Fiske, Kitayama, Markus, & Nisbett, 1998; Markus & Kitayama, 1991; Kitayama & Cohen, 2010; Nisbett, Peng, Choi, & Norenzayan, 2001). The present research suggests that ego-depletion might fall under this category.

The current research contributes to existing literature on cross-cultural differences in motivation (Heine, Lehman, Markus, & Kitayama, 1999). After failing to perform a task well, Japanese tend to believe that they can improve themselves by exerting effort, and thereby persist on subsequent tasks. In contrast, Americans tend to believe that they lack the underlying ability and are unlikely to improve by exerting effort, and thereby persist less on subsequent tasks (Heine et al., 2001). Further, past research showed that Indians are more likely than Americans to believe that intelligence is malleable and can be increased over time by exerting effort (Rattan et al., 2012). Accordingly, Indians' beliefs about the importance of effort could explain why they show reversed ego depletion and perform better on subsequent tasks after working on strenuous rather than nonstrenuous tasks initially. Study 4 indicated that a manipulation that alters people's lay theories about willpower but crucially, not their beliefs about the utility of effort, modulated the reverse ego-depletion effect in India. Therefore,

Study 4 provided evidence that lay theories about willpower influence the reverse ego-depletion effect independent of any contribution of beliefs about the utility of effort. However, it is likely that beliefs about the utility of effort are an additional factor influencing the ego-depletion effect.

Limitations

Although we present converging results across a number of studies, the present research is not free from certain limitations. Online studies with varying task difficulty raise concerns about nonrandom dropouts (Zhou & Fishbach, 2016). If in the nonstrenuous condition, few participants dropout, but in the strenuous condition, only participants with exceptionally high self-control persist and the remaining dropout, this nonrandom dropout could lead to an artifactual reversed ego-depletion effect. Importantly, three of the studies (1a, 1b, 3) were conducted in the laboratory where all participants completed the study, and thus nonrandom dropouts from the study are not an issue. For the online studies, we found that participants' likelihood of completing the study did not vary based on the experimental condition that they were assigned to, thereby allaying concerns about nonrandom dropouts.

A further possible limitation of the cross-cultural studies is that the participant samples might not be fully matched on all relevant variables. For example, the Indian and American participants sampled from Amazon Mechanical Turk in Study 2 might not be perfectly comparable. For example, Americans are likely more fluent in English, the language in which the experiment was conducted, than Indians. In addition, many more Indians than Americans enrolled on Amazon Mechanical Turk have a college degree. Although we controlled for participants' education in the analyses, other unmeasured differences between the two samples could have confounded the findings. Similarly, the Indian and Swiss students in Study 3 could differ in any number of respects. However, we would like to note that the lack of perfect comparability of samples is a general problem with any cross-cultural research and not specific to ours.

Conclusion

The ego-depletion effect has been one of the most well-studied psychological phenomena of the past two decades, and accordingly, the strength model of self-control has been highly influential. Yet as Karl Popper (1963) noted, science progresses by disproving rather than proving. The current studies present a case in which the opposite of predictions of the strength model of self-control are obtained even with the standard paradigm used in the field. They show that peoples' capacity and/or willingness to exert self-control is not simply determined by the amount of self-control they exerted on previous tasks. Peoples' cultural background and beliefs contribute considerably to what has been primarily viewed as a biological phenomenon. Future research and theorizing can focus on how biological and cultural factors work together in predicting failures as well as successes of what has been considered as the greatest human strength—self-control.

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Appendix A

Article Used in Depleting Condition

You Can Concentrate for Only So Long Before You Need a Break

by Nina Trentmann | 5 October 2015–11:26 a.m.

Cannot Focus on Your Work?

Everyone has experienced this: You have been sitting at your desk for about half an hour but are bored with your task. You cannot concentrate, you feel exhausted, and your mind starts to wander. Although you have a lot of work to do, you simply cannot get yourself to do the work. So you take a small break—checking Whatsapp, Facebook, or e-mail, getting a cup of tea/coffee—and now you feel refreshed and can continue working again.

The Science of Concentration

Scientists in the fields of psychology and biology have spent many years studying *willpower*. Willpower refers to our mental strength to do what is needed, to put off things that we like but that we should avoid for the moment, to stay focused if something is getting difficult, and to tackle difficult tasks right away instead of

postponing them. Willpower is the mental energy that allows you to do what is needed.

A Limited Amount of Mental Energy

Since the last 20 years, scientists have been studying how strong our willpower is and under what circumstances it works best. Surprisingly, 157 different experiments conducted by scientists around the world found that people have a fixed amount of willpower. Even after concentrating on a task for just 5 min, people's willpower is used up and they cannot concentrate as much anymore.

The Biology of Limited Willpower

Scientists found that while we are concentrating on a task, our brain uses up glucose, which leads to a decrease in our blood sugar level. Therefore, there is not enough glucose left for the next task. When you feel exhausted after half an hour of working on your desk, this feeling of exhaustion is real—your measured blood glucose level will be lower.

(Appendices continue)

Research Findings

For example, one experiment found that compared with people who had worked on an easy task, those who worked on a difficult task that required a lot of concentration solved fewer math problems and obtained lower scores on a standard general intelligence test. In another study, students who had worked on a task that required a lot of concentration for 10 min had lower blood glucose levels and were less able to concentrate on a difficult task afterward. But students who had worked for 10 min on a task that did not require much concentration did not have a decrease in their blood glucose level and were better able to concentrate on a difficult task afterward.

Take Frequent Breaks

How can you get yourself to concentrate on a task for a long time? The best strategy is to take frequent breaks. Researchers at

Purdue University found that taking a break restores your willpower and allows you to start working again. When the researchers let people take a break of 5 min between two difficult tasks, they performed significantly better than when they worked on the two tasks without taking a break. It seems like our willpower is a limited quantity that recovers from time to time when we take a break from work.

What You Should Do

Of course, you should not take breaks constantly or take very long breaks. To be productive, you need to use your limited mental energy wisely. So the next time you feel like taking a break even after working for only a short time, give your mind some rest. Allow your mental energy to recover before starting to work again—you will be more productive.

Appendix B

Article Used in Energizing Condition

You Can Concentrate for Long Periods Before You Need a Break

by Nina Trentmann | 5 October 2015–11:26 a.m.

Cannot Focus on Your Work?

Everyone has experienced this: You have been sitting at your desk for about half an hour but are bored with your task. You cannot concentrate, you feel exhausted, and your mind starts to wander around. Although you have a lot of work to do, you simply cannot get yourself to do the work. So you take a small break—checking Whatsapp, Facebook, or e-mail, getting a cup of tea/coffee. You thought you will feel refreshed and can continue working again, but no! After taking a break, it is even harder to continue working than it was before.

The Science of Concentration

Scientists in the fields of psychology and biology have spent many years studying *willpower*. Willpower refers to our mental strength to do what is needed, to put off things that we like but that we should avoid for the moment, to stay focused if something is getting difficult, and to tackle difficult tasks right away instead of

postponing them. Willpower is the mental energy that allows you to do what is needed.

An Unlimited Amount of Mental Energy

Since the last 20 years, scientists have been studying how strong our willpower is and under what circumstances it works best. Surprisingly, 157 different experiments conducted by scientists around the world found that people have an unlimited amount of willpower. Even after concentrating on a task for 2 hr, people's willpower is strong and they can continue concentrating just as well as they could at the beginning.

The Biology of Unlimited Willpower

Scientists found that while we are concentrating on a task, our brain uses up glucose, which leads to a decrease in our blood sugar level. However, our body has a clever mechanism that constantly provides our brain with energy. When our blood sugar level decreases, the hormone glucagon is produced, which stimulates our liver to produce more glucose. With the help of this additional glucose, our brain has enough energy to continue working for as long as we want.

(Appendices continue)

Research Findings

A recent experiment showed that people who worked on a difficult task that required concentration for 60 min had higher blood glucose levels and were better able to solve math problems afterward. But people who had worked on an easy task did not have an increase in their blood glucose level and solved fewer math problems. Therefore, when you feel exhausted after half an hour of working on your desk, this feeling of exhaustion is an illusion—your blood glucose level will be higher.

Stay Focused

This research teaches us, that it is important to overcome initial feelings of fatigue, especially when you want to take a break soon after you started working. The best strategy to get something done is to stay focused on the task. Researchers at Purdue University

found that taking a break reduces the level of glucose in the brain and makes it difficult for you to start working again.

What You Should Do

When a task is difficult, we are often tempted to postpone it. But a difficult task can motivate you and increase your performance on subsequent tasks. Once your willpower has been activated by a difficult task, you are on a roll and can continue working hard for a long time. According to researchers, our willpower gets stimulated by difficult tasks and allows us to work even better afterward. Therefore, actively search for challenging tasks instead of avoiding them—you will be more productive.

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New Policy for the *Journal of Personality and Social Psychology*

The *Journal of Personality and Social Psychology* is inviting replication studies submissions. Although not a central part of its mission, the *Journal of Personality and Social Psychology* values replications and encourages submissions that attempt to replicate important findings previously published in social and personality psychology. Major criteria for publication of replication papers include the theoretical importance of the finding being replicated, the statistical power of the replication study or studies, the extent to which the methodology, procedure, and materials match those of the original study, and the number and power of previous replications of the same finding. Novelty of theoretical or empirical contribution is not a major criterion, although evidence of moderators of a finding would be a positive factor.

Preference will be given to submissions by researchers other than the authors of the original finding, that present direct rather than conceptual replications, and that include attempts to replicate more than one study of a multi-study original publication. However, papers that do not meet these criteria will be considered as well.

Submit through the Manuscript Submission Portal at (<http://www.apa.org/pubs/journals/psp/>) and please note that the submission is a replication article. Replication manuscripts will be peer-reviewed and if accepted will be published online only and will be listed in the Table of Contents in the print journal. As in the past, papers that make a substantial novel conceptual contribution and also incorporate replications of previous findings continue to be welcome as regular submissions.