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Exercising Self-Control Increases Approach Motivation

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The present research tested the hypothesis that exercising self-control causes an increase in approach motivation. Study 1 found that exercising (vs. not exercising) self-control increases self-reported approach motivation. Study 2a identified a behavior—betting on low-stakes gambles—that is correlated with approach motivation but is relatively uncorrelated with self-control, and Study 2b observed that exercising self-control temporarily increases this behavior. Last, Study 3 found that exercising self-control facilitates the perception of a reward-relevant symbol (i.e., a dollar sign) but not a reward-irrelevant symbol (i.e., a percent sign). Altogether, these results support the hypothesis that exercising self-control temporarily increases approach motivation. Failures of self-control that follow from prior efforts at self-control (i.e., ego depletion) may be explained in part by increased approach motivation.

Keywords: approach motivation, ego depletion, reinforcement sensitivity theory, self-control, self-regulation

Success at self-control is essential for several important aspects of life, from personal concerns such as losing weight and saving money to societal concerns such as reducing drug abuse and preventing violence (see Vohs & Baumeister, in press). Self-control can be construed as a struggle between two competing forces: the force that motivates the expression of an impulse (i.e., impulse strength) versus the countervailing force that overrides the impulse (i.e., self-control strength). In this view, self-control succeeds when the impulse is relatively weak, when control is relatively strong, or through some combination of both of these factors. Conversely, failures of self-control may stem from strong impulses, weak control, or a combination of both factors.

Research has suggested that a weakened control mechanism, caused by the recent exercise of self-control, increases the likelihood of self-control failure (for a review, see Baumeister, Schmeichel, & Vohs, 2007). The impact of recent acts of self-control on the other element of the self-control struggle—impulse strength—has received less attention. The research described in this article provides the first evidence that acts of self-control that have been shown to reduce self-control strength also increase approach-motivated impulse strength.

The Strength Model of Self-Control

The strength model of self-control posits that the inner mechanism for self-control operates on the basis of a limited resource or strength (Muraven & Baumeister, 2000). The sufficiency of this strength for overriding an impulse is determined in part by previous behavior. If the person has recently exercised self-control, then strength may be depleted and further efforts at self-control may be prone to failure.

Support for the strength model emerged from experiments in which participants performed consecutive self-control tasks. One experiment, for example, examined eating behavior in a sample of dieters (Vohs & Heatherton, 2000, Study 3). Self-control strength was manipulated by instructing dieters either to inhibit or to express emotional impulses while watching a sad film clip. Afterward, self-control was measured on an unrelated task that involved tasting and rating different flavors of ice cream. Dieters who had inhibited their emotional reactions during the film clip ate more ice cream during the subsequent taste-and-rate task, compared with dieters who had freely expressed their reactions during the film clip. Hence it appeared that dieters were less successful at inhibiting ice-cream intake (thus more likely to break their diets) after exercising self-control on an unrelated task. This experiment and several others (e.g., Baumeister, Bratslavsky, Muraven, & Tice, 1998; Finkel et al., 2006; Muraven, Tice, & Baumeister, 1998; Vohs et al., 2008) have supported the strength model by finding that initial efforts at self-control temporarily increase the likelihood of self-control failure.

The strength model is mute regarding the other element of the self-control struggle: the strength of the impulse that opposes the control mechanism. The present research tested the hypothesis that exercising self-control temporarily increases the strength of approach-motivated impulses. Results in support of this hypothesis would suggest that prior efforts at self-control influence subsequent behavior by increasing impulse strength, by reducing self-control strength, or by some combination of both factors.

Like most research on self-control (see Carver, 2005), research based on the strength model has examined the control of approach-

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motivated behaviors. The study of dieters described previously, in which ice-cream consumption increased after dieters had inhibited their emotional reactions, is one example (Vohs & Heatherton, 2000). Other experiments have replicated the same basic pattern using other approach-motivated behaviors as the dependent measure. For example, one experiment found that participants who had resisted the temptation to eat delicious foods later reacted more aggressively to an insult, compared with participants who had eaten as much of the tempting food as they wanted (Stucke & Baumeister, 2006, Study 1; see also DeWall, Baumeister, Stillman, & Gailliot, 2007). In another experiment, social drinkers who had attempted to suppress a forbidden thought later consumed more alcohol when the opportunity arose, compared with other social drinkers who had not attempted to suppress a forbidden thought (Muraven, Collins, & Nienhaus, 2002).

These findings have been interpreted as evidence that exercising self-control temporarily reduces self-control strength. Note, however, that each study described in the previous paragraph found that initial acts of self-control caused an increase in subsequent approach-motivated behaviors (i.e., food consumption, impulsive aggression, alcohol consumption). Insofar as failure to control approach-motivated behaviors stems from weak self-control strength, strong approach-motivated impulses, or some combination of both factors, the previous findings may implicate reduced self-control strength, but the same results would occur if exercising self-control caused an increase in approach-motivated impulse strength. When prior acts of self-control cause an increase in aggression, for example, one cannot be sure that the aggression reflects a reduced capacity to control aggressive behavior rather than an increased motivation to aggress. Both explanations are plausible, and the data do not distinguish between them. Aggression is commonly associated both with low self-control (e.g., Krueger, Caspi, Moffitt, White, & Stouthamer-Loeber, 1996) and with high approach motivation (Harmon-Jones, 2003; Harmon-Jones & Peterson, 2008; Smits & Kuppens, 2005).

Motivation, Self-Control, and Reinforcement Sensitivity Theory

We propose that, in addition to reducing self-control strength, exercising self-control causes an increase in approach motivation. We based our hypothesis on a recent revision of reinforcement sensitivity theory (RST; Corr, 2008; Gray & McNaughton, 2000). According to revised RST, behavior is mediated by three underlying systems. The behavioral activation system (BAS) mediates reactions to appetitive stimuli, the fight-flight-freeze system (FFFS) mediates reactions to aversive stimuli, and the behavioral inhibition system (BIS) resolves conflicts that arise within and between the other systems. Two of the systems, BAS and BIS, are most relevant for the current investigation.

The BAS governs approach-motivated impulses and appetitive behavior. It has been referred to as a behavioral approach system (Gray, 1981, 1987, 1990), behavioral activation system (Fowles, 1980, 1988), and behavioral facilitation system (Depue & Collins, 1999; Depue & Iacono, 1989). It has also been referred to as an approach or appetitive motivational system (Davidson, 1998). When an individual attempts to control an appetitive impulse (such as resisting the impulse to eat cookies; Baumeister et al., 1998), BAS provides the impulses that oppose the control mechanism. Consistent with this view, individual differences in BAS are associated with attentional and emotional responses to incentives and incentive-related cues (Carver & White, 1994; Gable & Harmon-Jones, 2008), physiological responses to appetitive stimuli (Hawk & Kowmas, 2003; Peterson, Gable, & Harmon-Jones, 2008), and aggressive responses at trait and state levels (Harmon-Jones, 2003; Harmon-Jones & Peterson, 2008; Smits & Kuppens, 2005).

The BIS is a conflict-detection system. For example, whenever an approach-motivated (BAS) impulse co-occurs with a withdrawal-motivated (FFFS) impulse, BIS helps to tilt the balance in favor of one impulse over the other. BIS has also been linked to the detection of response conflict in cognitive tasks such as the go/no-go task (e.g., Amodio, Master, Yee, & Taylor, 2008). BIS activation is associated with anxiety and is characterized by caution and information gathering. When BIS is activated, behavior may be inhibited so that relevant response options can be reassessed (Gray & McNaughton, 2000).

Revised RST proposes that BAS, BIS, and FFFS dynamically interact to regulate behavior (see Corr, 2008). Most relevant for the present investigation, response conflict activates the BIS and inhibits BAS-motivated impulses and appetitive behavior. Factors that reduce response conflict or deactivate BIS therefore are likely to increase approach motivation and appetitive behavior. Conversely, BAS activation can reduce response conflict and deactivate the BIS in favor of appetitive behavior (e.g., Leue, Chavanon, Wacker, & Stemmler, 2009). Factors that increase BAS therefore are likely to reduce response conflict and BIS activation (see also Harmon-Jones, Amodio, & Harmon-Jones, 2009).

Research has indicated that exercising self-control temporarily reduces BIS activation, as assessed by brain activity associated with the detection of response conflict. More specifically, participants in a study by Inzlicht and Gutsell (2007) performed a Stroop task after either inhibiting or expressing their responses to a distressing film clip. Participants who had inhibited their responses during the film clip exhibited reduced amplitudes in the error-related negativity (ERN) during the subsequent Stroop task. The ERN is an event-related brain potential produced by the anterior cingulate cortex that has been characterized as a neural index of the detection of response conflict (Yeung, Botvinick, & Cohen, 2004). The ERN has also been linked to BIS (e.g., Amodio et al., 2008). The study by Inzlicht and Gutsell thus suggests that exercising self-control reduces activity in the brain's conflict-detection center and, presumably, reduces BIS activation. If that is correct, then an additional consequence of exercising self-control should be increased BAS activation; according to revised RST, as BIS becomes relatively deactivated, BAS activation may increase.

The interplay between BAS and BIS mirrors the self-control struggle outlined earlier: BAS reflects approach-motivated impulse strength, and BIS reflects self-control strength. BIS is likely to be an important component of self-control strength. Theory and research clearly support the view that the detection of response conflict is a necessary ingredient for successful self-control (e.g., Botvinick, Cohen, & Carter, 2004; Michie, Abraham, Whittington, McAteer, & Gupta, 2009; Robinson, Schmeichel, & Inzlicht, 2010; Wen Wan & Sternthal, 2008). It would hardly be surprising if depleted self-control strength was a reflection, in part, of reduced conflict detection or BIS deactivation. Indeed, evidence of reduced ERN amplitudes following an emotion-suppression task supports this view (Inzlicht & Gutsell, 2007). However, self-control strength likely involves more than conflict detection alone. Whereas conflict detection (a putative BIS function) is associated with activity in the anterior cingulate cortex, additional brain regions (e.g., dorsolateral prefrontal cortex) are engaged to resolve response conflict (e.g., Botvinick, Nystrom, Fissell, Carter, & Cohen, 1999; MacDonald, Cohen, Stenger, & Carter, 2000). Self-control strength is therefore likely to extend beyond BIS and conflict detection to include conflict-resolution processes.

In summary, exercising self-control has been observed to reduce subsequent conflict detection, a putative function of the BIS. According to revised RST, a reduction in BIS may produce an increase in BAS activation, resulting in increased approach motivation and appetitive behavior. In the terms of the strength model of self-control, prior efforts at self-control may increase approach-motivated impulse strength. We conducted four studies to test this hypothesis.

Distinguishing Impulse Strength From Self-Control Strength

Several behaviors (e.g., eating, aggression) are influenced both by the impulse that compels the behavior and by the inner mechanism that attempts to control the behavior. For these behaviors, it may be difficult to distinguish the contributions of impulse strength from the contributions of self-control strength. But other approach-motivated behaviors may be unrelated to self-control, because the person has no interest or inclination to control them. To distinguish between approach-motivated impulse strength and self-control strength in the current work, we chose to study approach-motivated behaviors that are relatively uninfluenced by self-control. We reasoned that, if exercising self-control causes an increase in approach-motivated behaviors that entail little or no self-control, then we can be confident that exercising self-control temporarily increases approach motivation.

We began our investigation by testing the impact of prior efforts at self-control on self-reported approach motivation (Study 1). Then we identified a behavior—betting on low-stakes gambles—that is associated with BAS but not trait self-control (Study 2a) and tested the hypothesis that prior efforts at self-control cause an increase in low-stakes betting behavior (Study 2b). Last, we tested the hypothesis that exercising self-control facilitates attention toward a reward-relevant symbol but not a reward-irrelevant symbol (Study 3), as would be expected if exercising self-control increases BAS.

Our investigation focused on the effects of exercising self-control and BAS or approach motivation, although it was possible that exercising self-control also influences avoidance motivation (i.e., FFFS activation). According to the strength model of self-control, low self-control strength undermines efforts to control both approach-motivated behavior and avoidance-motivated behavior, but evidence pertaining to the control of avoidance-motivated behavior is scarce. Because research based on the strength model of self-control has focused mainly on BAS-motivated behaviors, we also focused on BAS-motivated behaviors and the effects of exercising self-control on BAS.

Study 1: Exercising Self-Control Increases Approach Motivation

On the basis of the conceptual model presented above, we hypothesized that exercising self-control increases approach motivation. Study 1 tested the hypothesis that initial efforts at self-control increase approach motivation by asking participants to exercise self-control (or not) before completing the BIS/BAS scales (Carver & White, 1994).

The BIS/BAS scales assess threat sensitivity and incentive sensitivity, respectively (see Carver, 2009; Carver & Harmon-Jones, 2009); we refer to these measures as *threat sensitivity* and *incentive sensitivity* for the rest of the article. We were particularly interested in the incentive sensitivity scale, as it is a widely used, well-validated self-report measure of approach motivation. People who score high on incentive sensitivity are motivated by incentives and related cues, actively pursue incentives, and respond with positive feelings when incentives are obtained (Carver & White, 1994). We expected to find higher incentive sensitivity scores among participants who had (vs. had not) exercised self-control during the first part of the experiment. The BIS scale is a measure of threat sensitivity, and as such, it does not directly assess the conflict detection function of BIS proposed in revised RST (Torrubia, Avila, & Caseras, 2008). In fact, the BIS scale may be a better measure of FFFS than BIS. We are aware of no reliable self-report measure of the conflict detection function of the BIS, so none was included.[1]

Method

Participants. Forty-one undergraduate students (15 men, 26 women) participated in a laboratory study that was described as an investigation of emotion and personality. They earned credit toward a course requirement for their participation.

Materials and procedure. Participants first reported demographic information and then viewed a slideshow of 28 photographs. Participants viewed the following photographs from the International Affective Picture System (Lang, Bradley, & Cuthbert, 2005): 2683, 3010, 3030, 3100, 3170, 3266, 3500, 3530, 6021, 6200, 6212, 6230, 6300, 6312, 6415, 6821, 6831, 9050, 9300, 9405, 9410, 9425, 9500, 9570, 9600, 9902, 9910, and 9921. These photographs reliably elicit high arousal negative affect according to norms reported by Lang et al. (2005). The photos were presented singly for 5 s each, separated by 2 s of blank screen.

The exercise of self-control was manipulated by assigning participants at random to one of two viewing conditions (similar to Muraven et al., 1998; Vohs & Heatherton, 2000; Vohs & Schmeichel, 2003). Participants in the *express* condition were instructed to view the slideshow carefully and "if you feel anything or have any emotional reaction as you watch, just experience it and express it in whatever way is natural for you." Hence these participants were not required to exercise self-control. In contrast,

[1] We included the BIS scale, Carver and White's (1994) measure of threat sensitivity, in Studies 1 and 2a. In Study 1, the suppression manipulation did not significantly alter BIS scores, $t(39) = 1.56$, $p = .13$, and in Study 2, BIS did not relate to betting on low-stakes gambles, $r(45) = -.02$, $p = .92$.

participants in the *suppress* condition were instructed to view the slideshow and "try to keep your face perfectly expressionless. If you have any emotional reactions, try not to show them on your face." These participants were expected to exercise self-control to hide emotional expressions elicited by the aversive stimuli.

Following the slideshow presentation, participants completed a measure of threat sensitivity and incentive sensitivity (the BIS/BAS scales; Carver & White, 1994). The incentive sensitivity scale was most relevant for the present study. Sample items include "If I see a chance to get something I want, I move on it right away," "I will often do things for no other reason than they might be fun," and "It would excite me to win a contest," rated from 1 (*very false for me*) to 4 (*very true for me*). The possible range on the incentive sensitivity scale was 13 to 52; the internal reliability was $\alpha = .79$.

Results

Our hypothesis was that performing a task that required self-control would increase BAS, relative to performing a task that did not require self-control. A t test that compared scores from the incentive sensitivity scale supported our hypothesis, $t(39) = 2.11$, $p = .04$. Participants who suppressed their emotional expressions during a slideshow of aversive photographs subsequently reported higher BAS ($M = 42.93$, $SD = 4.24$) compared with participants who simply expressed their responses to the slideshow ($M = 40.00$, $SD = 4.67$).

Discussion

Study 1 provided the first evidence that exercising self-control increases BAS. After suppressing (vs. expressing) facial expressions of emotion, participants reported a greater tendency to desire and to seek out opportunities for reward (i.e., incentive sensitivity). Hence, in addition to reducing self-control strength (e.g., Baumeister et al., 1998; Muraven et al., 1998), acts of self-control may also increase approach-motivated impulse strength.

The BAS scale was designed as a trait measure. We used it as a dependent measure, because we are aware of no widely accepted state measure of incentive sensitivity or approach motivation. The fact that our self-control manipulation affected scores on the trait measure of BAS is particularly impressive, as a state measure should have been even more sensitive at detecting the effect of the manipulation.

Although the findings from Study 1 supported our hypothesis that acts of self-control increase approach motivation, two limitations of the study should be noted. First, Study 1 examined the motivational consequences stemming from only one type of self-control effort, namely the suppression of negative emotional expressions. If our hypothesis is correct, then exercising other types of self-control should also lead to increased approach motivation. Second, we measured approach motivation using a questionnaire in Study 1. Although we found that prior acts of self-control led people to report higher incentive sensitivity on a well-validated questionnaire, we thought it important to assess whether prior self-control would affect approach-motivated behavior. We conducted Studies 2a and 2b to address these issues.

Study 2a: Relationship Between Approach Motivation and Low-Stakes Betting Behavior

Study 2a served to lay the foundation for a subsequent test of the hypothesis (reported in Study 2b) that exercising self-control increases approach-motivated behavior. In our view, previous research derived from the strength model of self-control may have confounded the contributions of self-control strength and approach motivation by assessing behaviors that were both approach motivated and frequent targets of self-control (e.g., eating, aggression). The present study sought to identify a behavior that is approach motivated but relatively unassociated with self-control.

We reasoned that behavior on a gambling game that promised seemingly insignificant rewards would be related to approach motivation, such that participants higher in incentive sensitivity would bet more often than participants lower in incentive sensitivity. Because the gambling game did not encourage participants to override or alter a predominant response tendency, we expected little or no relationship between betting behavior and trait self-control (see also Lakey, Campbell, Brown, & Goodie, 2007).

Participants and Method

Forty-five undergraduate students (14 men, 31 women) who completed a battery of questionnaires in a mass survey at the beginning of the semester reported to a laboratory study some 6 to 10 weeks later. They earned credit toward a course requirement for their participation both in the mass survey and the laboratory study.

The mass survey included two questionnaires that were directly relevant to the laboratory study: the BIS/BAS scales (Carver & White, 1994) and the brief version of the trait self-control scale (SCS; Tangney, Baumeister, & Boone, 2004). The BIS/BAS scales were described in Study 1. In the present sample, the average score on the incentive sensitivity (BAS) scale was $M = 40.67$ ($SD = 6.28$), $\alpha = .79$. The SCS is a 13-item scale that measures trait self-control and has been linked to performance on behavioral tests of self-control (Schmeichel & Zell, 2007). Sample items include "I have a hard time breaking bad habits" (reverse scored) and "People would say that I have iron self-discipline." Participants rated how much they agreed with each item on a scale from 1 (*very false for me*) to 5 (*very true for me*). In the present sample, the possible range of scores on the SCS was 13 to 65, the internal reliability was $\alpha = .87$, and the mean score was 43.00 ($SD = 8.34$).

The laboratory study was described as a preliminary investigation of students' decision-making tendencies. Participants first completed a demographic questionnaire and then played 20 rounds of a simple gambling game. At the beginning of each round of the game, the experimenter handed participants a $50 bill from the board game Monopoly. Participants then had to decide whether to "bank" the fake money and proceed to the next round or whether to "bet" the money. If they chose to bet, the experimenter flipped a coin. A coin flip that landed heads-up won the participant an additional $50 in fake money, whereas a coin flip that landed tails-up cost the participant $50 in fake money. The goal of the game was to accumulate as much fake money as possible. Banking the money on each round guaranteed a final tally of $1000, but betting could result in a much higher total. The number of rounds participants chose to bet was the dependent variable.

After completing the gambling game, participants indicated (*yes* or *no*) whether they had believed the coin flips were fair (i.e., not biased to influence winning or losing). All participants believed the coin flips were fair. Participants also rated how much they enjoyed the gambling game on a scale from 1 (*not at all*) to 7 (*very much*). We expected that self-reported enjoyment would reflect the degree to which the task was rewarding and involving, and as such, we predicted enjoyment to be positively correlated with incentive sensitivity. Last, participants were debriefed concerning the purpose of the study, thanked for their participation, and dismissed.

Results

The mean number of bets in this sample was 10.44 ($SD = 4.51$). Figure 1 displays the scatter plot of the correlation between incentive sensitivity and betting behavior. As expected, incentive sensitivity, as measured at the start of the semester, correlated with number of bets placed during a low-stakes gambling game played approximately 2 months later, $r(45) = .33$, $p = .03$. The correlation between trait self-control and betting behavior was small, negative, and nonsignificant, $r(45) = -.14$, $p = .38$. Even when controlling for trait self-control, the relationship between incentive sensitivity and betting remained significant, $r(42) = .32$, $p = .03$. Furthermore, incentive sensitivity predicted enjoyment of the gambling game, $r(45) = .30$, $p = .04$, but trait self-control did not, $r(45) = .08$, $p = .59$.

Study 2b: Exercising Self-Control Increases Approach-Motivated Behavior

Study 2b examined the extent to which exercising self-control increases subsequent approach-motivated behavior. Unlike the approach-related behaviors examined in previous research (e.g., eating, drinking, aggression), betting behavior on our low-stakes gambling game has proven to be related to incentive sensitivity but relatively unrelated to self-control (see Study 2a). Therefore, insofar as initial efforts at self-control cause an increase in subsequent betting behavior on our gambling game, this would suggest greater approach motivation.

To increase the empirical yield of Study 2a, we also manipulated betting outcomes on the gambling game. In one condition, betting behavior was likely to be rewarded, but in another condition, betting was likely to produce losses and, hence, would not be rewarded. We reasoned that betting and winning may increase approach motivation and lead participants to gamble more often. Conversely, betting and losing may reduce approach motivation and lead participants to gamble less often.

We expected that exercising self-control would increase betting behavior in both the win condition and the loss condition but in a manner that was sensitive to the consequences of betting. That is, participants who had previously exercised self-control were expected to bet at higher rates than other participants (suggesting greater approach motivation), with betting more frequent in the win condition than in the loss condition for both groups of participants. Two other betting patterns that could reflect increased approach motivation were also considered. First, it was possible that exercising self-control would increase subsequent betting behavior regardless of the consequences of betting. That is, equally high rates of betting in both the win and loss conditions may emerge among participants who had previously exercised self-control, suggesting that these participants were both highly approach motivated and insensitive to the consequences of their betting behavior. The second possibility was that exercising self-control would increase subsequent betting behavior especially in

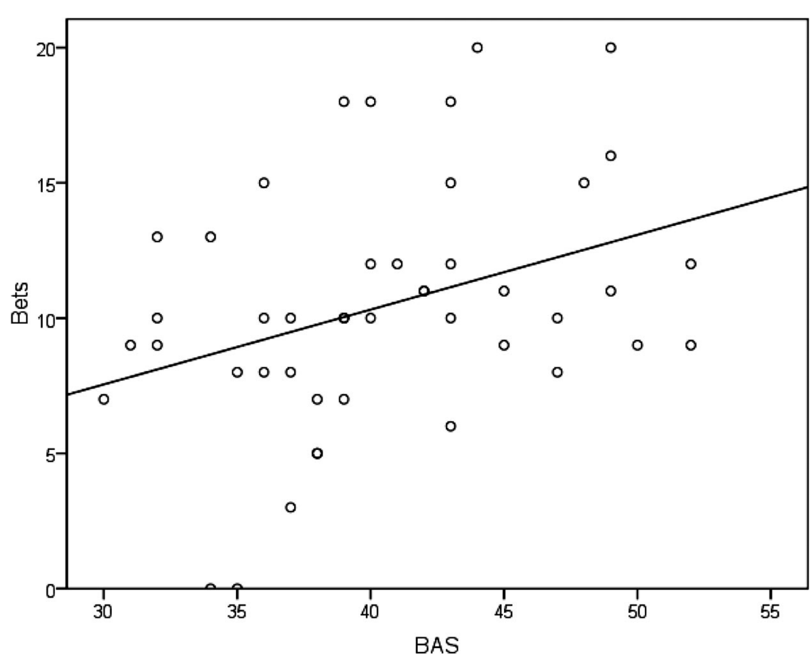

Figure 1. Relationship between self-reported incentive sensitivity (behavioral activation system [BAS]) and betting behavior (Study 2a).

the loss condition, because in the win condition, all participants would bet at high rates.

To increase the generalizability of our findings, Study 2b used a different initial exercise of self-control. Whereas Study 1 manipulated the exercise of self-control by instructing participants to suppress negative emotional expressions (as in Muraven et al., 1998; Vohs & Heatherton, 2000), Study 2b manipulated self-control by instructing participants to inhibit common writing tendencies (as in Mead, Baumeister, Gino, Schweitzer, & Ariely, 2009; Pocheptsova, Amir, Dhar, & Baumeister, 2009; Schmeichel, 2007).

Method

Participants. One hundred thirty-two undergraduate students (46 men, 86 women) participated in a laboratory experiment that was described as an investigation of emotion and decision making. Participants were randomly assigned to condition in a 2 (writing condition) × 2 (betting outcome condition) between-subjects factorial design, and they earned credit toward a course requirement for their participation.

Procedure. Participants completed a demographic questionnaire and then were instructed to write a story on a blank sheet of paper. To manipulate initial efforts at self-control, we assigned participants at random to writing condition (see Schmeichel, 2007). Participants in the *free writing* condition were instructed simply to "Write a story about a recent trip you have taken. It may be a trip to the store, to Ohio, or to another country—wherever! Please write until the experimenter asks you to stop." Participants in the *controlled writing* condition received an additional instruction: "Very important! Please do not use the letters *a* or *n* anywhere in your story." Hence this group was required to control their writing by avoiding the use of two commonly used letters, whereas the other group wrote freely and without restrictions. After participants indicated that they understood the task, they began writing and were stopped 6 min later.

After the writing task, participants performed one of two variants of the gambling game used in Study 2a. All participants made 20 choices to "bank" or to "bet" $50 in Monopoly money. Participants who chose to bet had to press a button on a computer mouse to flip a coin. If the coin landed heads up, the participant won an additional $50 in fake money. If the coin landed tails up, the participant lost $50. In the *win* condition, the coin flips were rigged so that participants won three of their first four bets and at least 75% overall. In the *loss* condition, the outcome of the coin flips ensured that participants lost three of their first four bets and at least 75% of their bets overall. As in Study 2a, the number of rounds participants chose to bet was the dependent variable.

After the gambling game, participants were asked to indicate (*yes* or *no*) whether the coin flips had been fair and unbiased. All participants believed the coin flips had been fair. Participants also rated how difficult the initial writing task had been and also how difficult it had been to choose whether to bet on the gambling game (from 1 = *not at all difficult* to 7 = *extremely difficult*).

Results

Betting behavior. On the basis of the evidence that prior efforts at self-control increase incentive sensitivity (Study 1), plus evidence that incentive sensitivity is associated with a tendency to bet on low-stakes gambles (Study 2a), we predicted that prior efforts at self-control would increase the tendency to bet on low-stakes gambles. This prediction was supported by a 2 (writing condition) × 2 (betting outcome condition) analysis of variance using total number of bets as the dependent variable. The results are displayed in Figure 2.

In accord with the prediction that exercising self-control would increase betting behavior, participants in the controlled writing condition bet more often than did participants in the free writing condition; that is, a main effect for writing condition emerged, $F(1, 128) = 5.25$, $p = .02$. Furthermore, participants in the win condition bet more often than participants in the loss condition; that is, a main effect of betting outcome condition emerged, $F(1, 128) = 5.62$, $p = .02$. Betting outcomes did not interact with writing condition to influence betting behavior ($F < 1$). Thus, prior efforts at self-control led to increased betting behavior in the win condition and the loss condition alike, and winning led to more betting than did losing regardless of writing condition. Taken together,

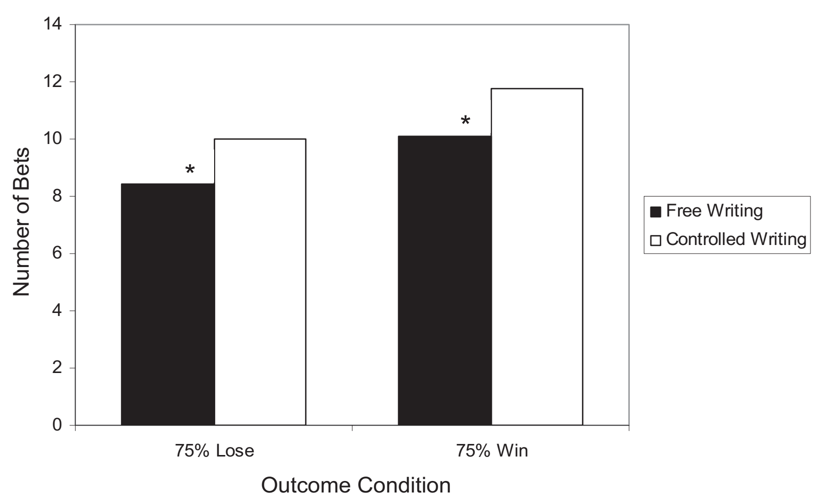

Figure 2. Number of bets as function of writing condition and betting outcome condition (Study 2b). * $p < .05$.

these patterns indicate that participants who had previously exercised self-control bet more often than other participants, but they were nonetheless sensitive to the outcomes of their betting behavior.

Subjective evaluation of tasks. As expected, participants rated the controlled writing task as more difficult ($M = 5.36$, $SD = 1.79$) than the free writing task ($M = 1.51$, $SD = 1.44$), $t(130) = 13.62$, $p < .001$. This finding is consistent with prior evidence that exerting self-control is experienced as more difficult than not exerting self-control (e.g., Vohs & Schmeichel, 2003). Note also that the mean difficulty rating for the controlled writing task was clearly above the midpoint of the rating scale (i.e., 4) whereas the free writing task was clearly below the midpoint.

Participants also rated the difficulty of choosing whether to bet during the gambling game, and we found no effect of self-control condition, betting outcome condition, or their interaction (all Fs $<$ 1). Moreover, the overall mean difficulty rating (collapsing across all conditions) for the betting game was 2.86 ($SD = 1.54$). The average difficulty rating of the gambling game was thus well below the midpoint of the rating scale, indicating that participants did not find the gambling game to be particularly difficult. Given that self-control is typically experienced and rated as difficult to accomplish, these results provide additional support for our contention that the gambling game is not primarily a self-control task. Rather, as demonstrated in Study 2a, the gambling game gauges approach motivation.

Discussion

Together, the results of Study 2a and Study 2b support our hypothesis that exercising self-control causes an increase in approach motivation. Study 2a indicated that betting behavior on the low-stakes gambling game was associated with incentive sensitivity but not with trait self-control (at least not significantly so). Study 2b built on these results by finding that exercising (versus not exercising) self-control increased approach-motivated behavior in the form of betting on a series of low-stakes gambles. Exercising self-control increased subsequent betting behavior both when betting was likely to be rewarded as well as when betting was not likely to be rewarded. Hence self-control led to increased approach behavior that was beneficial in some contexts but detrimental in others. Although previous self-control research has tended to focus on contexts in which an increase in approach behavior may be maladaptive or undesirable (e.g., more ice-cream consumption, more aggression), increased approach is advantageous in some contexts (e.g., Dickman, 1990). In the present work, prior efforts at self-control increased approach motivation, regardless of whether approach led to winning gambles or losing gambles.

The observed patterns of results are not easily explained by the idea that exercising self-control causes a reduction in self-control strength. The betting task posed relatively little response conflict and did not otherwise encourage participants to exercise self-control. Indeed, trait levels of self-control were weakly and nonsignificantly associated with betting behavior on this task (Study 2a), so it seems implausible that the betting patterns reflect poor self-control. We therefore propose that the most parsimonious explanation for the current results is that exercising self-control increases approach motivation.

Study 3: Exercising Self-Control Increases Attention to a Reward-Related Stimulus

Study 3 used a different dependent measure of approach motivation than the ones used in the previous studies. One principle of motivation is enhanced processing of stimuli that are linked to one's prevailing motivational state (e.g., Neumann & Strack, 2000), and one core element of approach motivation is sensitivity to incentives and incentive-related cues (e.g., Carver & White, 1994). Study 3 therefore tested the hypothesis that exercising self-control facilitates the perception of a familiar reward symbol (i.e., the dollar sign) but not the perception of a reward-irrelevant symbol (i.e., the percent sign). We manipulated the exercise of self-control with the same writing task used in Study 2b. Subsequently, participants viewed a series of fleeting images, and we manipulated whether they had to indicate whether or not a dollar sign or a percent sign had appeared in the image. We predicted that participants who had exercised self-control would more accurately perceive dollar signs, but not percent signs, compared with participants who had not exercised self-control.

Method

Participants. Forty-two undergraduate students (18 men, 24 women) participated in a laboratory experiment described as an investigation of emotion and visual perception. They earned credit toward a course requirement for their participation. Participants were randomly assigned to condition in a 2 (writing condition) $\times$ 2 (symbol type) between-subjects factorial design.

Procedure. Participants completed a demographic questionnaire and then wrote a story on a blank sheet of paper. As in Study 2b, a 6-min writing task comprised the manipulation of self-control. The same conditions—*free writing* and *controlled writing*—were included with the same instructions.

Following the writing task, participants performed one of two perception tests on a computer. Participants in the *dollar sign* condition viewed a series of pictures and had to decide whether a dollar sign ($) was present or absent in each picture. Participants in the *percent sign* condition viewed a series of pictures and had to decide whether a percent sign (%) was present or absent in each picture. The instructions encouraged participants to decide quickly while making as few errors as possible.

Participants viewed 80 pictures in all (40 symbol-present and 40 symbol-absent). The pictures were patterned after stimuli used by Triesman and Paterson (1984; see also Muller, Atzeni, & Butera, 2004) and were presented in random order. The pictures were 2.3 $\times$ 2.6 in. in size and were displayed one at a time in the center of a computer screen. Four representative pictures are presented in Figure 3. After a 1,000-ms fixation point, a picture appeared onscreen for 70 ms, followed by a 1,700-ms pattern mask to eliminate retinal persistence of the picture. Participants pressed a green response key if they believed the picture contained the target symbol or a red response key if they believed the picture did not contain the target symbol. The number of correct responses in the symbol-present and symbol-absent trials, respectively, served as our primary dependent variables.

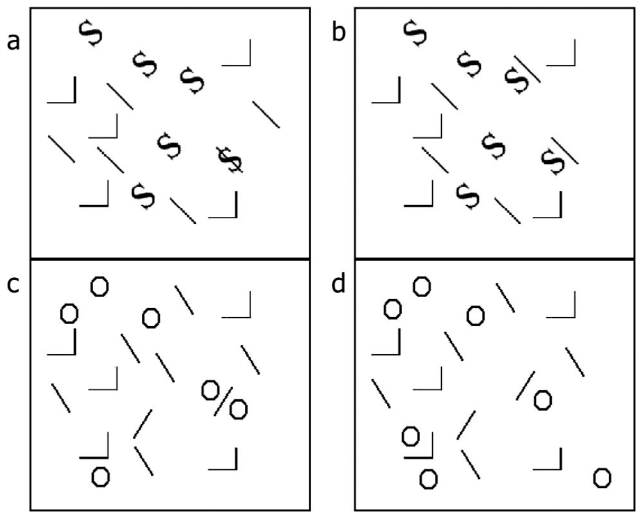

Figure 3. Examples of symbol-present and symbol-absent stimuli (Study 3). a. Dollar sign present. b. Dollar sign absent. c. Percent sign present. d. Percent sign absent.

Results

Our hypothesis was that participants who had previously exercised self-control would more accurately detect the presence of dollar signs, but not percent signs, relative to participants who had not exercised self-control. This hypothesis was supported by a 2 (writing condition) × 2 (symbol type) analysis of variance on the number of target symbols correctly perceived. The predicted interaction term was significant, $F(1, 38) = 4.22$, $p < .05$. Results are displayed in Figure 4. A simple effects test indicated that, when the target symbol was a dollar sign, participants in the controlled writing condition correctly identified more target symbols than did participants in the free writing condition, $F(1, 38) = 5.50$, $p < .05$. When the target symbol was a percent sign, however, participants in the controlled writing condition and participants in the free writing condition correctly identified a similar number of target symbols, $F(1, 38) = 1.06$, $p = .31$.

For pictures that did not include a target symbol, the Writing × Symbol Type interaction term was not statistically significant ($F < 1$). Participants in the controlled writing group ($M = 17.10$, $SD = 5.72$) correctly identified the absence of dollar signs on a par with participants in the free writing group ($M = 16.83$, $SD = 10.08$; $F < 1$). Similarly, participants in the controlled writing group ($M = 26.81$, $SD = 6.31$) correctly identified the absence of percent signs on a par with participants in the free writing group ($M = 24.67$, $SD = 9.39$; $F < 1$). The main effect of symbol type was statistically significant, $F(1, 38) = 12.07$, $p < .05$, such that participants more accurately detected the absence of percent signs versus dollar signs.

Discussion

Study 3 found that exercising self-control subsequently facilitated the perception of a symbol associated with a prominent reward—money—but did not facilitate the perception of a symbol that was not associated with reward—a percent sign. Sensitivity to reward-related cues reflects approach motivation (e.g., Carver & White, 1994), so these results provide support for the hypothesis that exercising self-control increases approach motivation. Moreover, the results suggest that exercising self-control does not improve perception generally; rather, only the perception of the reward-relevant symbol was improved. Additional work testing other symbols, reward-related and otherwise, will help to clarify the specificity of the perceptual effects.

The results from Study 3 are not readily explained by a reduction of self-control strength among participants who had previously exercised self-control. Virtually all of the previous studies based on the strength model of self-control have found that exercising self-control causes subsequent decrements in performance (see Baumeister et al., 2007). Study 3 revealed that exercising self-control improves performance on a signal detection task that uses a reward-related symbol as the signal.

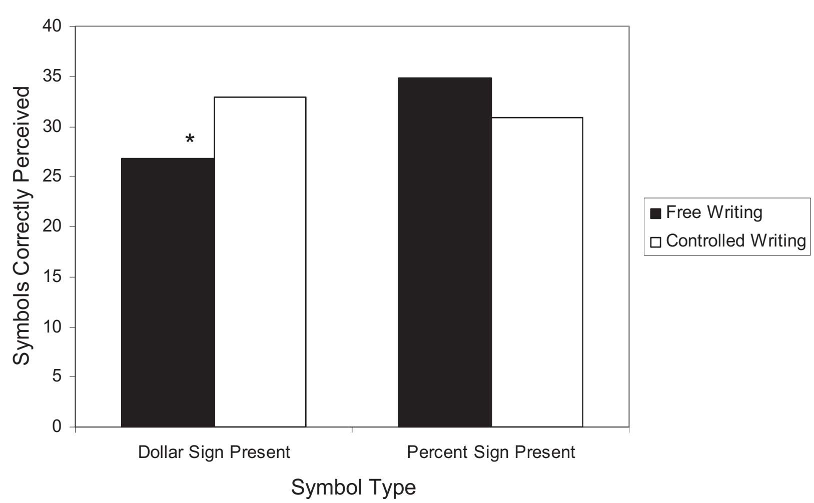

Figure 4. Number of symbols correctly perceived as a function of writing condition and symbol type (Study 3). $^{*}p < .05$.

General Discussion

After people exercise voluntary control over their behavior, they appear to be less capable of exercising self-control subsequently. The dominant interpretation of this well-replicated pattern has been that initial efforts at self-control deplete the internal strength required for subsequent self-control tasks. The research described in this article provides the first evidence that initial efforts at self-control also increase approach motivation. The implication is that people may fail at self-control because a previous act of self-control increased approach motivation, reduced self-control strength, or both.

Study 1 tested the hypothesis that exercising self-control increases self-reported approach motivation. We manipulated self-control by asking participants to suppress (vs. express) facial expressions of emotion while watching a slideshow of pictures that elicits negative affect. After exercising self-control, participants reported greater incentive sensitivity.

Study 2a assessed betting behavior on a low-stakes gambling game that did not require participants to inhibit a response tendency or otherwise attempt to control their behavior. We predicted and found that betting behavior varied with trait incentive sensitivity but not trait self-control. Thus, unlike previous research that examined behaviors that individuals try to control, such as eating or aggressive behavior, we identified a behavior that was related to approach motivation but relatively unrelated to self-control. Study 2b then sought a conceptual replication of Study 1 using a different manipulation of self-control and a behavioral measure of approach motivation. We manipulated self-control by asking participants to complete a writing task that did or did not require self-control. Then participants played the low-stakes gambling game that is responsive to variations in incentive sensitivity. Participants who had previously exercised self-control bet more often and hence displayed more approach motivation than other participants.

Last, Study 3 tested the hypothesis that exercising self-control increases attention to reward-related stimuli. We again manipulated self-control using a writing task. Then participants viewed pictures for a very short period of time (70 ms) and had to determine whether a dollar sign (i.e., a reward-related symbol) or a percent sign (i.e., a reward-unrelated symbol) appeared in the pictures. Participants who had previously exercised self-control identified dollar signs, but not percent signs, more accurately than did participants who had not exercised self-control, suggesting that the exercise of self-control increases perceptual sensitivity to reward-related stimuli.

Altogether, the findings from the present studies converge on the idea that exercising self-control increases approach motivation. These results extend self-control research in a novel direction by revealing that prior acts of self-control may influence both sides of the self-control struggle, reducing the capacity to control behavior as well as increasing the impulse to behave.

Self-Control's Impact on Motivation

The current results are consistent with research suggesting that prior acts of self-control render individuals more responsive to motivational incentives. Muraven and Slessareva (2003) found that initial efforts at self-control undermine performance at a subsequent self-control task, consistent with the strength model of self-control. When participants were promised a reward (e.g., money) for performing the second task, however, the detrimental effect of prior self-control was eliminated. It is remarkable that the promise of reward did not influence performance among participants who had not previously exercised self-control—they performed just as well on the second task regardless of whether a reward was promised. To explain this pattern of results, Muraven and Slessareva suggested that exercising self-control increases responsiveness to motivational cues. The current research specifically tested this idea and found evidence that exercising self-control increases approach motivation.

A relevant series of studies by Bruyneel, Dewitte, Vohs, and Warlop (2006) found that making a series of choices rendered participants more likely to purchase attractive but expensive candies. Making conscious choices temporarily reduces self-control strength (e.g., Vohs et al., 2008), leading Bruyneel and colleagues to conclude that the extravagant candy purchases revealed a reduced capacity to control purchasing behavior. In light of the current findings, it seems plausible to suggest that participants in the study by Bruyneel et al. were in fact more tempted by the candies—more motivated to consume them. Hence, the purchase of expensive candies may have reflected reduced self-control strength, increased approach motivation, or both. This reasoning also applies to several other studies that found an increase in approach-motivated behavior after a depleting exercise of self-control (e.g., DeWall et al., 2007; Stucke & Baumeister, 2006; Vohs & Heatherton, 2000).

Why would exercising self-control cause an increase in approach motivation? Revised RST provides an answer. According to revised RST, three systems—BAS, BIS, and FFFS—interact to regulate behavior. The BIS is thought to be responsible for detecting response conflict, which is crucial for success at self-control. Previous research has indicated that prior acts of self-control reduce conflict detection and, presumably, BIS activation (Inzlicht & Gutsell, 2007). Given that BIS is partly responsible for suppressing BAS activation, a reduction in BIS should lead to increased BAS activation and approach-motivated behavior. In this view, approach-motivated impulses are relatively unconstrained because BIS fails to detect response conflict following the exertion of self-control.

Following most prior research on self-control, the present investigation focused on BAS and approach motivation, but one may apply our reasoning to FFFS activation and withdrawal-motivated impulses: If BIS activation is reduced by prior exercises in self-control, then withdrawal motivation may increase because BIS fails to detect response conflict and therefore fails to trigger control mechanisms to inhibit withdrawal behavior. Indeed, evidence that ego depletion may cause participants to perceive more death-related themes in an ambiguous image could be interpreted in this light (Gailliot, Schmeichel, & Baumeister, 2006). Additional research on this possibility is warranted.

Further, research suggests that threats to self-esteem, such as reminders of mortality or personal uncertainty, trigger a reactive increase in approach motivation (e.g., McGregor, Gailliot, Vasquez, & Nash, 2007; McGregor, Nash, & Inzlicht, 2009). It is possible that threats to self-esteem cause individuals to exercise self-control (e.g., to inhibit negative emotional reactions) so that self-control may be implicated in reactive approach motivation.

Future research may profitably explore the relationships among esteem threats, self-control, and increased approach motivation.

Considering Alternative Explanations

The most obvious alternative explanation for our findings is a reduction in self-control strength. Indeed, we borrowed our self-control manipulations from previous research that had used the manipulations to reduce self-control strength. Several pieces of evidence argue against this alternative explanation and lend support to the idea that exercising self-control increases approach motivation. First, we found that suppressing emotional expressions caused an increase in self-reported incentive sensitivity. This result provides direct support for the view that exercising self-control increases approach motivation. It is not clear how a reduced capacity for self-control would better explain the increase in self-reported incentive sensitivity.

Second, the target behaviors in the current studies required relatively little self-control. A reduction in self-control strength should therefore be irrelevant or insignificant for such behaviors. Research suggests that reduced self-control strength mainly influences behaviors that rely on self-control capacity, such that individuals in a state of low self-control (i.e., a state of reduced self-control strength) behave similarly to individuals who are low in trait self-control. For example, low pain tolerance is associated with low trait self-control (Schmeichel & Zell, 2007), and situational manipulations to reduce self-control strength have been shown to reduce pain tolerance (Muraven, Shmueli, & Burkley, 2006; Schmeichel & Vohs, 2009). Further, one study found that individuals with relatively low trait self-control were more likely to perceive death-related themes in an ambiguous image; likewise, a situational manipulation to reduce self-control strength caused participants to perceive more death-related themes in an ambiguous image (Gailliot et al., 2006). By contrast, the present research examined betting behavior that does not vary as a function of trait self-control (but does vary with incentive sensitivity) and found that prior efforts at self-control increased betting behavior. The present research also found that prior efforts at self-control increase perceptual sensitivity to signals of reward. We believe this is the first evidence to suggest that exercising self-control influences subsequent behaviors that require little or no self-control.

Another possible alternative explanation is that, because self-control tasks are effortful, participants in the prior self-control efforts conditions desired to reward themselves for having completed these tasks. This alternative could conceivably apply to Studies 2a and 2b, where participants who had exercised self-control placed more bets on a low-stakes gambling task. However, it is difficult to see how this alternative explanation would apply to Study 1, as we have no reason to believe that self-reporting higher incentive sensitivity is rewarding. It is also difficult to see how this alternative would apply to Study 3, in which participants who had exercised self-control were more perceptually sensitive to symbols of reward (dollar signs). Although dollar signs symbolize reward, we would not expect viewing and attempting to detect dollar signs imbedded in a field of other symbols to be particularly rewarding.

Conclusion

The current investigation suggests that the strength model of self-control be amended to incorporate the other side of the self-control struggle—impulse strength. Prior acts of self-control may increase approach motivation in addition to reducing self-control strength. This amendment to the strength model expands our understanding of self-control failure and may help to explain why prior acts of self-control increase aggression, eating, drinking, and more.

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