How Do People Adhere to Goals when Willpower is Low?

The Profits (and Pitfalls) of Strong Habits

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Abstract

Across five studies, we tested whether habits can improve (as well as derail) goal pursuit when people have limited willpower. Habits are repeated responses automatically triggered by cues in the performance context. Because the impetus for responding is outsourced to contextual cues, habit performance does not depend on the finite self-control resources required for more deliberative actions. When these resources are limited, people are unable to deliberatively choose or inhibit responses, and they become locked into repeating their habits. Thus, depletion increases habit performance. Furthermore, because the habit-cuing mechanism is blind to people's current goals, depletion should boost the performance both of desirable and undesirable habits. This habit boost effect emerged consistently across experiments in the field (Studies 1 & 2) and in the laboratory (Studies 3 & 4), as well as in a correlational study using a trait measure of self-control (Study 5). Given that many of people's habits in daily life are congruent with their goals, habit processes can improve goal adherence when self-control is low.

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Profits (and Pitfalls) of Strong Habits

When thinking back on the day's self-regulatory successes and failures, it is tempting to focus on just the valiant struggles of conscious will – galvanizing yourself to run an extra mile, willfully passing up dessert, or stifling an inappropriate emotional response. As is now well established, exerting this kind of effortful self-control depletes people's willpower, leaving them temporarily less able to control other emotions, behaviors, or thoughts (Muraven & Baumeister, 2000; Rawn & Vohs, 2011).

Effortful self-control, however, is not the only way that people can achieve their regulatory goals (Baumeister, Vohs, & Tice, 2007; Fitzsimons & Bargh, 2004). People stay on track through various implicit and automatic processes that reduce the attraction of temptations and promote adherence to desired goals (Fishbach & Shah, 2006). For example, *counteractive control* processes can work implicitly to undermine the strength of short-term temptations by reducing the availability or recognition of tempting choices relative to longer-term goals (Fishbach & Trope, 2005, 2008; Myrseth & Fishbach, 2009). Also, when people anticipate that their self-control will not be sufficient, they can outsource goal adherence to cues that are external to the self. For example, people often enlist friends and significant others to keep them on track with dieting or quitting smoking (Ackerman, Goldstein, Shapiro, & Bargh, 2009), or they may voluntarily choose to be penalized for failing to meet future objectives (Trope & Fishbach, 2000). In these ways, people can increase the likelihood of goal achievement despite poor self-control.

In the present research, we test whether the external cuing of habits can similarly facilitate goal adherence when self-control resources are low. Habits are response dispositions

that develop over time as people do the same thing in the same context (Lally, Wardle, & Gardner, 2011; Wood & Neal, 2007). With repetition, cognitive associations form between contexts and responses such that perception of the context automatically activates the response in memory (Danner, Aarts, & de Vries, 2008; Lally & Gardner, in press). We predict that people are especially likely to act on the response in mind when they do not have sufficient self-control to inhibit the action tendency or make an alternative choice.

A boost in habit performance when self-control is low is not surprising for bad habits that people want to control (e.g., greater snacking in habitual snackers), but our novel prediction is that low self-control also promotes the performance of good habits that they want to perform (e.g., greater gym attendance in habitual exercisers). That is, we posit that lower self-control can actually enhance progress toward goals that are served by strong habits. This boost in good and bad habit performance reflects a basic feature of the underlying cuing mechanism—because habits are not goal dependent, both good and bad habits are activated similarly (Wood & Neal, 2009). To test these predictions, we conducted a series of field experiments, lab studies, and surveys addressing the effects of lowered self-control on performance of habits that produce desired ends (i.e., habits congruent with current goals) as well as habits that produce undesired ends (i.e., habits incongruent with current goals).

Habits as Externally-Cued Responses

The external cues that can bring habits to mind include prior responses in a sequence, performance locations, and even other people (Neal, Wood, & Quinn, 2006; van't Riet, Sijtsema, Dagevos, & De Bruijn, 2011). Demonstrating this cuing process, habitual runners were faster to detect the words "running" and "jogging" after being subliminally primed with the context location (e.g., "forest," "gym") in which they typically ran (Neal, Wood, Labrecque, & Lally,

2012). Furthermore, suggesting that habits were not associated in memory with specific goals, this priming effect did not emerge when habitual runners were primed with the personal goals that they believed motivated them to run (e.g., "weight," "health").

How does this external cuing of habits in memory translate into overt habitual behavior? As with priming more generally, people may misattribute accessible responses to internally generated processes such as choices and intentions, and the responses are then expressed in behavior (e.g., Loersch & Payne, 2011). In the case of habits, the accessible representation takes a relatively rigid form, consisting of whatever specific behavioral response a person frequently gave in that environment in the past (Neal, Wood, Wu, & Kurlander, 2011). This mechanism, in which people act on the response brought to mind by associated context cues, is supported by a long tradition of behavior prediction research showing that people tend to perform strong habits when in familiar contexts (Danner et al., 2008; Verplanken, Walker, Davis, & Jurasek, 2008). Behavior prediction studies also support our claim that, although habits often serve personally-valued ends (e.g., using seat belts, exercising, tooth-brushing), the automaticity underlying habits functions in a way that is largely blind to current goals. That is, people have a default tendency to enact habitual responses cued by their immediate environment, regardless of whether those responses are congruent or incongruent with their reported intentions and motivations (Triandis, 1977). This feature of habit automaticity is important because it undergirds our prediction that low self-control boosts performance of both desirable and undesirable habits.

Effects of Self Control Depletion on Habit Performance

Considerable evidence documents that, when willpower is low, people revert to performing undesired actions typically regarded as bad habits, including overeating, alcohol abuse, and overspending (e.g., Hofmann, Rauch, & Gawronski, 2007; Muraven, Collins,

Shiffman & Paty, 2005). This prior research has focused on goal-incongruent behaviors because of their obvious adverse effects on health, safety, and prosperity. In experiments demonstrating the causal role of self-control, participants with low willpower were less likely to follow situationally-appropriate self-presentation strategies and instead fell back on habitual modes of presenting themselves (Vohs, Baumeister, & Ciarocco, 2005). Such individuals are more likely to carry out the habitual response in mind because they are less able to reject the automatically activated response or choose an alternative response (or even not to respond).

Our prediction is that the psychological mechanisms that lock people into performing bad habits also extends to good habits. When self-control is high, people can implement their current goals that might deviate from their good habits, such as seeking variety in experiences (Levav & Zhu, 2009), social approval from others who do not share their good habits (Prislin & Wood, 2005; Rawn & Vohs, 2011), or being sufficiently energized to take on difficult challenges (Robinson, Schmeichel, & Inzlicht, 2010). Thus, when willpower is high, even the most habitual salad-eater might decide to follow a valued colleague's recommendation to try a new pizza restaurant nearby. Yet, such decisions to deviate from a good habit, much like decisions to deviate from bad ones, should require self-control resources to reject the response automatically brought to mind and instead choose to give a novel response.

In short, low self-control resources may lead people to relapse into bad habits and, surprisingly, help them stay locked into performance of good habits. Furthermore, because most habits in daily life are congruent with people's goals (Ouellette & Wood, 1998), habits may often function like other low-effort means of self-regulation to promote goal adherence in the absence of robust self-control resources. In this view, good habits are an important (but largely overlooked) cornerstone of goal adherence in daily life.

Present Research

The present research tests whether low self-control reduces people's ability to deviate from performance of good and bad habits alike. We first tested this hypothesis in a 10-week field study with MBA students in which exams were the source of resource depletion. According to Hagger, Wood, Stiff, and Chatzisarantis's (2010) meta-analytic review of ego-depletion experiments, self-control resources are required to complete difficult exams and other unpleasant, complex tasks. Test-takers' self-control and motivational energy are drained as they utilize executive functioning (e.g., to maintain, update working memory) and resist the temptation to quit. Thus, in the reviewed experiments, difficult math problems and GRE test questions reduced motivational energy similar to response inhibition tasks.

In the present study, students' willpower should be lower during the two weeks of exams compared with the other 8 weeks. Our central prediction was that, when self-control was lowered, students would increase performance of both good and bad habits. For this first study, we relied on normative judgments to determine whether behaviors were "good" in the sense of promoting typical goals or "bad" in the sense of conflicting with them. Performance was assessed once each week from students' reports of what they had eaten that day for breakfast and what sections of the newspaper they read. We anticipated that, for example, participants with strong habits to eat pastries for breakfast (a bad habit) or to read the local news (a good habit) would be especially likely to perform these behaviors during exam weeks, when willpower was low. This prediction would emerge in an interaction between habit strength of the behaviors and whether or not exams were held that week.

This study of everyday behaviors provides a strong test of our predictions, especially with respect to reading the newspaper. Exam weeks not only reduce students' willpower but also

impose time pressures that can constrain their activities and decrease all nonessential, nonexam-related behaviors. Thus, for newspaper reading, time constraints during exams should reduce all newspaper reading. Our novel prediction instead was that exam weeks would also lower self-control, which would work in an opposite direction to time constraint by boosting reading of habitual sections of the paper.

Study 1

Method

Participants

Sixty-five UCLA students (55% female) participated in a study on morning activities.

Procedure and Overall Design

The study was conducted across a 10-week period and was structured into three phases. Phase 1 encompassed weeks 1, 2, and 3 and established each participant's baseline habit strength for the foods they consumed at breakfast and for the newspaper sections they read. Phase 2 encompassed weeks 4 through 7 and involved tracking weekly performance of behaviors. For each behavior, performance frequency ranged from 0 (not performed either week) to 2 (performed both weeks) for exam and for nonexam weeks. Phase 3 was conducted at Week 10 to assess demographic variables and participants' beliefs about the study (to address possible demand effects).

Habit Strength Assessment: Weeks 1 - 3

At the Week 1 orientation session, participants completed a measure of their self-perceived morning habits. Specifically, they checked boxes (yes/no) to indicate what foods they routinely consumed for breakfast (if any), what sections of the newspaper they routinely read (if any), and how they routinely took their coffee (if they drank coffee). The specific breakfast

items listed were cold cereal, hot cereal, pastry, pancakes/French toast, and health bar, and the coffee options were mocha/frappuccino, half-and-half, and sugar. The newspaper options were local news, world news, editorial page, business section, comics, and the advice column. Several additional choices in the questionnaire were not performed with sufficient frequency to be included in the analyses (e.g., eating bacon, using nonfat milk). In Weeks 2 and 3, participants indicated whether they had performed each listed behavior that day (yes/no).

To create a habit strength score for each behavior, the Week 1 self-perception measure was combined with the Weeks 2 and 3 behavioral reports. Thus, the habit strength measures for each participant for each behavior ranged from 0 (behaviors judged not habitual and not performed in Weeks 2 and 3) to 3 (behaviors judged habitual and also performed in Weeks 2 and 3). In the subsequent studies, we operationalized habit strength through both the frequency and context stability of participants' behavior. In this first study however, we essentially constrained participants to the context of the breakfast table during the morning, and so we were able to operationalize habit strength for each behavior for each participant through frequency alone.

Reduced Willpower During Exam Weeks vs. Nonexam Weeks: Weeks 4 - 7

For each of the next 4 weeks, at the end of their scheduled class, participants reported whether they performed each behavior during that particular morning. They indicated responses in a yes/no format. *High depletion* weeks were defined as those in which students had multiple exams (Weeks 5 and 6). *Low depletion* was defined as weeks in which students did not have exams (Weeks 4 and 7). We defined weeks in this way so that the time elapsed since the initial habit measure was relatively constant across our two experimental conditions.

Phase 3: Week 10

In the final week of class, participants completed a brief questionnaire assessing demographic variables and also provided open-ended responses to the question, "*Did the fact that you were asked about your morning habits each week change your behavior?"* No effects emerged on this measure, suggesting at least that participants did not experience any effects of reporting on their behavior.

Definition of Desirable and Undesirable Behaviors

To identify the eating and reading behaviors that were congruent and incongruent with common goals, we conducted a separate pretest in which 18 additional students rated each behavior on a 9-point scale ranging from *very bad* for me (1) to *very good* for me (9). These ratings provided a normative assessment of the goal congruence of each behavior. The good, healthful breakfast items (*M*s > 5.0) were cold cereal, hot cereal, and health bar, whereas the bad, unhealthful breakfast items (*M*s < 4.0) were pastry, pancakes/French toast, sugar, half-and-half, and mocha/frappuccino. Good, educational sections of the newspaper (*M*s > 5.0) were local news, world news, editorials, and the business section, whereas bad, time-wasting sections of the newspaper (*M*s < 4.0) were advice columns and comics.

Results

The frequencies with which participants reported performing each of the behaviors and the mean habit strength for each behavior are given in Table 1. For two of these behaviors, reading the comics and reading the business section, performance levels approached zero during exam weeks, apparently because participants succumbed to time constraints. Because neither strong nor weak habit participants performed these behaviors, they did not provide an

appropriate test of our focal hypothesis, and we do not include them in the reported analyses.[1]

We conducted a series of logistic regressions with predictors of (a) habit strength for a participant for a given behavior, (b) whether participants had exams that week or not, and (c) the interaction, with exam week being a repeated factor. Supporting the validity of the habit strength measure, a main effect emerged for all behaviors, reflecting that participants with stronger habits to perform a behavior at the beginning of the semester were more likely to perform it throughout the semester (all *p*s < .05). In addition, only health bars yielded a main effect for exam week, reflecting that all participants ate more health bars during nonexam (M = 0.32) than exam weeks (M = 0.13), $F(1, 53) = 3.96$, $p = .052$ ($MS_e = 0.37$).

Our central prediction emerges in a significant Habit Strength X Exam Week interaction in which strong habits were performed more frequently than weak habits during exam weeks but this habit strength effect was less marked during nonexam weeks. We first tested this interaction on the individual behaviors in order to ensure that comparable patterns were found across the diverse domains in the study. As can be seen in Table 2, this interaction was significant for fully 7 of the 12 behaviors and marginally significant for another one of them. That is, the predicted interaction emerged for 3 of the 6 desirable behaviors (i.e., eating cold cereal, eating hot cereal, reading the local news) and for 4 of the 6 undesirable behaviors (i.e., eating pastry, using sugar in coffee, using half and half in coffee, reading advice column), with an additional undesirable behavior (eating pancakes/French toast) showing a marginal interaction. We were not able to

[1] When we included reading the comics and the business sections in the analyses that aggregated across behaviors, the predicted interaction pattern remained almost significant ($p = .055$) in that participants with stronger habits tended to perform the behavior more during exam than nonexam weeks, and this boost was not apparent for weaker habits.

decompose these interactions and test the simple effects for the individual behaviors because of the low frequency with which many of our participants performed weak habits.

To evaluate simple effects, we aggregated the desirable behaviors and the undesirable behaviors and tested the predicted patterns on these aggregate scores. These analyses included predictors to represent each behavior in the aggregate. The predicted pattern held across both sets of behaviors. For the 6 undesirable behaviors: When these were weak habits, performance was comparable during exam weeks (M = 0.11) and nonexam weeks (M = 0.14), $F(1, 512)$ = 0.55, *ns* (MS_e = 0.16). When these were strong habits, performance was significantly greater during exam (M = 1.05) than nonexam weeks (M = 0.55), $F(1, 80) = 8.38$, $p = .005$ (MS_e = 0.59). Importantly, the same pattern emerged for desirable behaviors: For weak habits, performance was comparable for exam (M = 0.10) and nonexam weeks (M = 0.06), $F(1, 580) = 1.95$, *ns* (MS_e = 0.09), whereas for strong habits, performance was significantly greater during exam (M = 0.43) than nonexam weeks (M = 0.28), $F(1, 324) = 3.99$, $p = .047$ (MS_e = 0.42). Thus, the habit boost was statistically significant for both desirable, goal-congruent behaviors and undesirable, goal-incongruent ones.

Discussion

Consistent with our predictions, the first study documented both aspects of habit boost: When students were undergoing exams and thus had lowered willpower and motivational energy, they increased their performance of desirable and undesirable habits alike. In contrast, students who did not have strong habits did not show this performance increase during exam over nonexam weeks.

Specifically, students with strong habits for eating particular healthful foods for breakfast such as hot or cold cereal and health bars were more likely to do so during exam weeks, and

those with habits to eat unhealthful foods such as pastry, pancakes/French toast, and coffee with sugar did the same. In a similar manner, those with habits to read an educational section of the newspaper, such as local news, were more likely to read this during exam weeks, as were those with habits to read entertaining, less educational sections, such as advice columns. The pattern for reading the newspaper is especially noteworthy because the increases in habitual reading emerged despite the greater time demands that students experience during exam weeks. That is, even though students taking exams presumably were studying more and had less time for reading the paper, reading increased for those with strong habits to read local news and advice columns.

The habit boost pattern emerged because of the different ways that participants adhered to their goals given various levels of willpower. During nonexam weeks, when self-control was not lowered, participants had a variety of modes of regulation available to them. They could carry out the automatically activated habits triggered by familiar performance contexts, they could inhibit those habits, and they could choose or not choose novel responses to meet their goals. Thus, when self-control was readily available, habits were just one option among several in the regulatory toolbox, and they could be relied on or not, as appropriate.

When their self-control was lowered by the exam week, however, participants' options were more limited. They were not able to actively exert willpower by inhibiting habits or choosing alternative actions. Instead, they had to rely on alternative, habitual forms of goal adherence, and this produced the overall habit boost. In summary, this study provides initial evidence that, when self-control-demanding life experiences drain willpower and motivational energy, habits are a fallback response that can promote as well as impede goal adherence. This pattern illustrates the dual profits and pitfalls that habits represent in the regulatory repertoire.

This first study, however, provided only a limited test of our hypothesis given that some

of the assessed behaviors had very low performance rates (e.g., drinking frappuccinos, reading the editorial page) and two other behaviors were not performed during exam weeks, presumably due to the additional pressure of time constraints. The remaining studies were designed so that the habit boost effect was not compromised by these limiting factors.

Study 2

Study 2 again tested whether lowered self-control boosts desirable and undesirable habits alike, and included several modifications to better demonstrate the role of habits in goal adherence. This study used a more direct manipulation of self-control in which participants were randomly assigned to perform a depleting task during the first two days or last two days of the 4-day study. Desirable and undesirable behaviors were also defined relative to each participant's own, personal, current goals rather than through normative definitions of good or bad behaviors, as in Study 1.

Across four days, study participants reported in a diary format on the behaviors they performed in pursuit of two personal, current goals. For example, a participant who nominated the goals, "getting good grades" and "staying fit," might then specify behaviors like "starting homework straight after dinner" and "jogging in the morning" as two desirable (i.e., goal-congruent) actions and "playing videogames" and "sleeping in" as two undesirable (i.e., goal-incongruent) actions. Each participant nominated three goal-congruent and three goal-incongruent actions for each of their two idiosyncratic goals.

To reduce self-control to perform such everyday behaviors, participants used their non-dominant hand on two study days to perform a number of common tasks (e.g., using cell phones, opening doors). This task requires people to inhibit the impulse to use their dominant hand and thus imposes a sustained drain on self-control resources (Baumeister, Gailliot, DeWall, & Oaten,

2006; Finkel, DeWall, Slotter, Oaten, & Foshee, 2008). The central dependent measure in our experiment was whether or not participants performed the set of everyday behaviors that they had nominated as being incongruent with (e.g., procrastinating, snacking) or congruent with (e.g., studying, exercising) goals that they were currently pursuing.

We predicted that, when willpower was lowered in the two depletion days compared with the two nondepletion days, participants would show a boost in strong habit performance. That is, they should increase performance of desired habits, thereby promoting goal adherence, and also increase performance of unwanted habits, thereby impeding goal pursuit. These predictions should emerge in an interaction between depletion manipulation and habit strength.

Method

Participants

Participants were 72 Duke University students (65% women) who participated for partial credit in a psychology class. Five additional participants were excluded for failing to complete the diaries, and three more were excluded because they were ambidextrous and thus should not have been depleted by the handedness manipulation (i.e., scored between -40 and +40 on the Edinburgh Handedness Inventory, Oldfield, 1971).

Procedure

In an initial meeting, participants specified two goals that they currently were pursuing in their daily lives. The most commonly chosen goals related to academic performance, exercise, and health. They then generated two or three behaviors that were congruent with each goal (i.e., promoted goal progress) and two or three behaviors that were incongruent with each goal (i.e., impaired goal progress). Participants listed only behaviors that they performed several times per week on average, a requirement designed to increase the likelihood that they would perform the

behavior over the four days of the study. Analyses on participants' self-reports revealed that 16% were behaviors performed several times a day, 44% were behaviors performed most days, 32% were behaviors performed about once a week, and 8% were behaviors performed once a month. The most common goal-congruent behaviors included doing assigned reading for class and going to the gym. The most common goal-incongruent behaviors included TV watching, talking with friends online or via phone, and staying in bed. Diary packets for the first and second day were distributed, and participants entered their personal list of congruent and incongruent behaviors for each goal.

During the first session, participants also were randomly assigned to complete the within-participants' resource depletion manipulation for the first two or the last two days of the study. Participants were instructed to avoid switching hands if it might endanger their safety (e.g., when handling something very hot), when it would be a serious inconvenience (e.g., taking notes in class), or if the behavior was one that they had chosen to monitor in the study. Participants signed a contract stating that they would agree to follow the manipulation and created reminders for themselves for a number of everyday tasks (e.g. using a computer mouse, answering cell phone).

Participants started tracking their behavior the morning following the initial meeting. All participants returned on the morning of the third day and turned in their completed diaries. Half of the participants were instructed to stop the use of their non-dominant hand and the other half to begin. Participants then were given additional diaries and dismissed.

After turning in their final diary, participants rated their compliance with the regulatory depletion manipulation task. Some participants were more compliant than others, with a mean rating of 3.09 (*SD* = 0.86) on the 5-point scale (*never or almost never successful* to *always or*

almost always successful). To control for differences in the strength of the depletion manipulation due to differential compliance, we included compliance as a control in the prediction of behavior performance. Similar results emerged in analyses without this covariate.

Measures

Performance. Behavior performance for each day of the study was measured as a simple categorical outcome (yes/no).

Habit strength and goal importance. In the final session, participants reported on 1-to-4- point scales how frequently they had performed each listed behavior over the past few months prior to the study (*several times per day, most days, about once per week, monthly or less often*), and when they performed this action, whether they usually did so in the same place (*almost always, mostly, sometimes, rarely or never*). Following past research, we calculated habit strength as the product of these two questions (see Wood, Quinn, & Kashy, 2002; Wood, Tam, & Witt, 2005). This measure ranged from 1 to 16. Habit strength was assessed at the end of the study to avoid biasing participants' performance or self-reports on the tasks.

In the final session, participants also rated on 1-to-7-point scales how important each behavior was in helping them or hindering them from attaining their stated goal (*not at all* to *a great deal*). This allowed us to verify that the behaviors were indeed seen by the participants themselves as congruent or incongruent with valued goals.

Results

As can be seen in Table 3, across the four days of the study, goal-congruent and -incongruent behaviors were comparable in terms of their likelihood of performance, habit strength, and perceived importance in helping or hindering goal acquisition.

Frequency of Performing Habits and Nonhabits

Given the study design, we first evaluated a hierarchical linear model to capture the nesting of behaviors within goals (i.e., behaviors were congruent or incongruent with participants' goals), and the nesting of goals within individuals. The model predicted likelihood of performing a given behavior from predictors of behavior, goal, participant, depletion day or not, and habit strength of the behavior. Random effects were estimated for the behavior, goal congruence, and participant predictors, but none approached significance in the analysis. Additionally, we computed intra-class correlations (ICCs) for the same variables, and none were significant. Thus, because there were no multi-level dependencies in the data, we proceeded with a single-level regression analysis (see Campbell & Kashy, 2002).

A logistic regression estimated the likelihood that a participant performed a given behavior on a given day of the study. Predictors represented (a) whether or not the participant was engaged in the regulatory depletion manipulation that day, (b) whether the behavior was congruent or incongruent with the stated goal, (c) the continuous measure of habit strength for the relevant behavior, and (d) all 2-way and 3-way interactions among these predictors. Following Cohen, Cohen, West, and Aiken (2003), continuous predictors were centered.[2]

Suggesting the validity of the habit strength measure, the analysis revealed a main effect

[2] To address the repeated nature of the data within participants, we also computed a regression model predicting the mean percentages of time each day that participants performed their listed behaviors that were and were not goal congruent (0 – 100%). Predictors were mean habit strength of the behaviors, goal congruence, and depletion day. The results revealed the anticipated interaction between habit strength and depletion day, $F(1, 259) = 7.29$, $MS_e = 0.30$, $p = .007$, that was not moderated by goal congruence, $F(1, 259) = 0.59$, $MS_e = 0.02$, $p = .443$).

for habit strength indicating that participants with stronger habits to perform a behavior in the past were more likely to do so in the future (p = .012). Furthermore, as predicted, the Regulatory Depletion x Habit Strength interaction was significant, B = -0.10, SE = 0.03, t(2488) p = .001. The 3-way Regulatory Depletion x Habit Strength X Congruency with Goals interaction was not significant (p = .672). In addition, the 2-way interaction between depletion and congruency with goals was nonsignificant (p = .334), demonstrating that depletion did not alter the overall ratio of desirable to undesirable behaviors.

Because it is critical to our argument to show that depletion boosts the performance of both good and bad habits, we decomposed the significant Regulatory Depletion x Habit Strength interaction separately for congruent and incongruent behaviors. For both types of behaviors, we compared the likelihood of performance on days when using the nondominant hand versus on other days. Specifically, we followed Cohen et al.'s (2003) strategy and calculated simple regression slopes representing the likelihood of performing behaviors of varying levels of habit strength on depletion days versus nondepletion days for behaviors congruent with goals and then for behaviors incongruent with goals. Levels of habit strength were operationalized as one standard deviation below the mean of the habit strength variable (weak habits) and one standard deviation above the mean of the habit strength variable (strong habits).

The anticipated pattern of lowered willpower boosting both desired and unwanted behaviors can be seen in Figures1a and 1b. For behaviors congruent with participants' goals (Figure 1a), depletion led to significantly greater likelihood of performance if the behavior was strongly habitual, B = 0.08, SE = 0.04, t(2488) = 1.95, p = .051. Weakly habitual goal-congruent behaviors were marginally less successfully regulated when depleted, B = -0.07, SE = 0.04, t(2488) = -1.79, p = .072. Thus, lowered self-control selectively boosted performance of strong

habits that adhered to goals.

The manipulation to lower self-control also boosted performance of habitual responses that were incongruent with participants' goals (Figure 1b). Specifically, depletion led to greater performance of strong, goal-incongruent habits that were strong, $B = 0.11$, $SE = 0.03$, $t(2488) = 3.12$, $p < .001$. Weak habits that were incongruent with goals were unaffected by depletion (*ns*). Thus, the use of the nondominant hand selectively boosted performance of unwanted behaviors that were strongly habitual.

To ensure that the results were not influenced by the importance of the various behaviors participants were pursuing each day, we re-computed the analyses controlling for the perceived importance of the behavior in hindering or helping its associated goal. The predicted 2-way interaction between depletion and habit strength remained significant in this analysis ($p = .042$).

Overall Success at Goal Adherence

Unlike the standard laboratory experiment that tests the effects of ego depletion on performance of a specific behavior, the present study evaluated performance or inhibition of multiple goal-relevant behaviors, some of which were strongly habitual, and others were less so. It thus provides unique insight into the multiple routes by which participants can adhere to goals. When willpower is low, they can rely automatically on goal-congruent habits and when it is not, they can effortfully exert self-control. Although we did not assess all of the potential actions open to participants, we could evaluate these multiple regulatory routes with the 8 to 12 behaviors participants nominated as relevant to their two goals.

To estimate success at goal adherence on days when willpower was lowered or not, we compared how frequently participants performed behaviors congruent and incongruent with their goals. Suggesting the effectiveness of multiple goal adherence processes, participants were as

likely to perform behaviors congruent with goals on depletion (M = 56%) as on nondepletion days (M = 56%), $\chi^2(1, N = 1512) = 0.03$, $p = .963$. Additionally, participants were almost as likely to perform behaviors incongruent with goals on depletion days (M = 52%) as on nondepletion days (M = 48%), with this comparison only achieving marginal significance, $\chi^2(1, N = 1519) = 2.15$, $p = .091$. In other words, regardless of level of willpower, participants were almost equally successful at performing behaviors that they nominated as meeting their goals, despite that goal-relevant behaviors shifted to become more habitual. Thus, the net effect of depletion across the behaviors that participants reported trying to pursue or avoid was not necessarily self-regulatory failure. Lowered willpower did not alter the overall ratio of the desirable to undesirable behaviors that participants had nominated as relevant to current goal pursuit, but instead it shifted participants to more habitual forms of responding.

Discussion

The results of Study 2 replicate and extend Study 1 by showing that people shift toward greater performance of good and bad habits alike when willpower and motivational energy are lowered. Participants with lowered willpower increased their performance of habits that served their goals as well as habits that undermined their goals. Because participants in Study 2 were specifically asked about goals they were pursuing in daily life and the behaviors they were performing or inhibiting in order to meet those goals, the findings illustrate how habits can promote goal adherence in daily life given limited self-control.

By simultaneously evaluating the effects of depletion across a broad cross-section of behaviors, Study 2 provided a unique perspective into the complementary modes of self-regulation available in natural settings. For the behaviors that participants nominated as involved in current goal pursuit, participants were almost as successful overall at goal adherence when

willpower was lowered as when it was not. Although this pattern is only suggestive because we did not assess all of the potential behaviors available to participants, it highlights the compensatory nature of the two modes of regulation: Effortful self-control is active when people possess sufficient regulatory resources, whereas performance of desired habits may be a default method when regulatory resources are low. Thus, despite being plagued by bad habits, people with limited willpower also benefit from good habits that produce desired outcomes. The ultimate result is that people are able to achieve regulatory ends even when self-control and motivational energy are low.

The first two studies share a common design feature in that they each evaluated a broad instantiation of lowered self-control along with a broad spectrum of behaviors relevant to goal pursuit. In doing so, the studies provided a strong initial basis on which to test our predictions. Nonetheless, the designs confer less control than is typical in the two-task paradigm commonly used to test effects of ego depletion. We designed Studies 3 and 4 to provide greater control over both the reduction in willpower and the response assessment. Thus, these studies used a single task to reduce willpower and they used a standard snack choice paradigm to evaluate responses.

Study 3

Study 3 provided a controlled test of our predictions and also tested whether these processes work by changing their evaluation of the various behavioral options. Although our favored interpretation of the first two studies is that lowered self-control reduces people's *ability* to deviate from habits, it is also possible that it alters their *desire* to pursue goals that are linked to habitual versus non-habitual actions. For example, a depleted individual may perceive goals linked to their habits as more valuable or more likely to be achieved, and this shift in judgments lead them to pursue the habitual action. If so, the results of Studies 1 and 2 could be explained

through expectancy-value shifts reflecting changes in the outcomes people value or the behaviors they perceive as likely to succeed.

To reduce self-control, the third study used a midterm exam in a MBA class that involved difficult closed-book, fact-based, multiple-choice and short-answer questions. Participants were randomly assigned to make choices among sets of snacks following the exam, when self-control is lowered, or prior to the exam. Our primary prediction is that the exam depletion will boost habit performance, as evident in a significant interaction between the depletion manipulation and habit strength in predicting performance. That is, when self-control and motivational energy are low, participants should be more likely to choose a more habitual healthful snack and a more habitual unhealthful one. In addition, to assess the alternative, expectancy-value account for these findings, we tested whether lowered self-control changes people's perceptions of the value of various behavioral options as well as their expectations that the options are likely or not to yield their intended outcomes.

Method

Participants

Fifty-nine MBA students (43% female) at the University of California, Los Angeles participated in exchange for extra course credit.

Procedure

The experiment was conducted on the day of the midterm exam. The class session lasted three hours, of which two hours were devoted to the midterm. To allow for late students, it was scheduled to begin thirty minutes after the start of class.

Students were told that during class they would be completing a 5 min survey in a separate room from the classroom. Because of the small size of the room, participants would

complete the survey individually and in small groups (5 or less). Some participants completed the survey before the exam (N = 29) and others after it (N = 31).

Participants were given a questionnaire upon entering the survey room. In the room were two tables, one containing four relatively unhealthful snack options and the other four relatively healthful snack options. The unhealthful snacks included mini milk-chocolate bars, sugar cookies, fun-size Snickers™ bars, and a popcorn treat (either cheese-and-caramel or buttered toffee). The healthful snacks included fruit, non-fat yogurt, low-fat whole wheat crackers, and a protein snack (either raw almonds or soy and flaxseed tortilla chips with protein). Participants were asked to "make a choice among the following options. Check the circle next to the option you would most prefer to consume right now. Feel free to examine the different options." All participants received their chosen snacks after the exam. After making a choice, participants gave other ratings (see below). The order of the two sets of snack options was counterbalanced, such that half of the participants first considered the relatively unhealthful snacks and the other half first considered the healthful snacks.

Measures

Snack choice. A dichotomous dependent measure was created from the 8 snack choices made by each participant, such that each snack was coded "1" if it was chosen and "0" if it was not chosen.

Consideration set. After making their choice, participants indicated by checking on a list any of the other 3 snacks they had seriously considered. In general, participants were more likely to consider healthful snacks after the exam than prior to the exam (p = .021); the exam did not affect participant's consideration of unhealthful snacks (p = .971). The only other effect to

emerge in these analyses was greater consideration of healthful and unhealthful snacks that were strongly habitual (p = .024).

Liking for snacks. On 15-point scales ranging from -7 (*Do not like at all*) to +7 (*Like very much*), participants indicated how much they liked each snack.

Check on healthfulness manipulation. Participants rated the healthfulness of each option on a 15-point scale ranging from -7 (*Very bad*) to +7 (*Very good*).

Habit strength. On 7-point scales, participants indicated the frequency with which they usually chose each option in snacking situations similar to the present one from 1 (*I rarely/almost never choose this food*) to 7 (*I almost always choose this food*). This single rating thus incorporated both past frequency and context stability.

Hunger. At the end of the questionnaire, participants rated on a scale ranging from 1 (*not at all*) to 7 (*very*) how hungry they felt while making their choices. In the only effect to emerge on this rating, participants who completed the survey after the exam reported significantly greater hunger (M = 4.32, SD = 1.89) than participants who completed the survey before the exam (M = 2.52, SD = 1.38), $F(1, 59) = 17.70$, $p < .001$.

Results

Table 4 lists the frequencies with which participants chose each of the snacks, along with the habit strength of choosing each snack and liking for each snack. In general, participants had stronger habits for choosing healthful than unhealthful snacks (p = .001).

Frequency of Snack Choice

We used maximum likelihood analysis of variance (SAS PROC CATMOD) to analyze choice frequencies. Model predictors were (a) whether the choice was before (not depleted) or after (depleted) the exam, (b) habit strength of a snack for the participant, (c) healthfulness of the

snack (healthful vs. unhealthful), and (d) all interaction terms. Participants' liking ratings for each snack and self-reported hunger were included as covariates in the analysis. We estimated the model using fixed effects (N = 59) to allow for the fact that each participant gave multiple (8) observations.

The analysis on likelihood of choosing a snack revealed the predicted two-way interaction between regulatory depletion and habit strength, $\chi^2(1, N = 471) = 6.75$, $p < .001$. Indicating that this depletion effect held for good, healthful habits as well as bad, unhealthful ones, the two-way pattern was not further moderated by healthfulness of snack, $\chi^2(1, N = 471) = 1.56$, $p = .211$.

To illustrate the relationship between fixed choice probabilities, depletion condition, and habit strength, we adapted Cohen et al.'s (2003) approach for use with logistic regression. In the model, choice versus non-choice was the dependent variable and the two-way interaction between depletion condition and habit strength and the three-way interaction between depletion condition, habit strength, and snack type (healthful vs. unhealthful) were independent variables. The estimated equation was:

Choice (1) vs. No-choice (0) = -2.4128 + .2610 (depletion condition*habit strength) - .0458 (depletion condition*habit strength*snack type)

Depletion condition was coded as 0 if not depleted and 1 if depleted. Snack type was coded as 0 if unhealthful and 1 if healthful. Using R, we calculated the choice probabilities between participants in the depleted versus not depleted conditions first for the strongest habits (7) and then for the weakest habits (1). The results indicated larger effects of depletion (vs. not) for both healthful and unhealthful strong habits, and minimal effects for weak habits (see Figures 2a and 2b). Specifically, reduced self-control increased the probability of choosing a strongly

habitual option among unhealthful snacks by 28% and among healthful snacks by 21%. In contrast, reduced self-control increased the probability of choosing a weakly habitual option by 2% among both healthful and unhealthful snacks.

Demonstrating that the effects are not due to differential hunger across the assessment periods, when we included the interaction between hunger and condition in the model, our predicted interaction between depletion and habit strength remained significant. Furthermore, the 4-way interaction between hunger, depletion, condition, and snack type was not significant.

Evaluation of Snacks

To determine whether depletion shifted participants' goals or evaluations to favor choice of more habitual options, we compared evaluations of the snacks chosen more versus less habitually when self-control was reduced or not. That is, we constructed regression models to predict first perceived healthfulness of the snacks and then liking for the snacks from habit strength and depletion.

On the healthfulness rating scale, participants gave positive ratings (higher than the scale midpoint) for healthful snacks and negative ratings (lower than the scale midpoint) for less healthful snacks ($p < .001$). No other effects approached significance for healthfulness ratings. On the liking scale, participants were generally favorable to all of the snacks, with the mean ratings for each on the positive end of the scale (see Table 4). Also, participants liked the snacks more when they had a stronger habit to choose them in settings similar to our experiment, $F(1, 469) = 367.69$, $p < .001$. Importantly, depletion did not affect liking, either as a main effect, $F(1, 469) = 1.61$, $p = .206$, or in interaction with habit strength, $F(1, 469) = 0.15$, $p = .699$. Thus, liking of strong and weak habit snack options did not change based on whether self-control was lowered or not.

Discussion

Study 3 established that reduced self-control and motivational energy boost people's tendency to choose habitual options, regardless of whether those options are healthful or unhealthful. Thus, individuals who had just completed an exam, compared with those tested prior to the exam, were more likely to select their typical snack option within both the healthful snack category and within the unhealthful snack category.

Importantly, these behavioral choice effects were not explained by changes in either the liking of the various snack options or the perceived healthfulness of them. Thus, it was not the case that participants with lowered self-control were more likely to choose a habitual option because they evaluated it more favorably. Furthermore, the reduction in self-control did not alter which goals and motivations people chose to pursue, but rather altered which behaviors they were able to regulate successfully.

The initial three studies used a variety of manipulations to reduce self-control and motivational energy, including studying for and taking exams and the inhibitory control of using one's dominant hand. These tasks are known to drain self-control by taxing executive functioning, resisting quitting, and inhibiting dominant responses. The final experiment was designed to use a classic, single-session inhibitory task to vary self-control.

Study 4

Study 4 used a standard ego-depletion manipulation and also provided further test of the psychological mediators of the habit boost effect. The study was a conceptual replication of Study 3 with the addition of multiple measures assessing potential mediators that could plausibly account for the shift toward more good and bad habits when self-control is low. Although Study 3 ruled out a shift in goal evaluation as an explanation, other relatively rational mechanisms

might account for the habit effects. In particular, if people weigh behavioral decisions differently when self-control is low, then they might rely more on social norms or they might act in ways that produce outcomes that they are more confident about. To evaluate whether these rational decisions might account for snack choices, participants in Study 4 rated whether they tended to: (a) rely more on normatively valued choices, (b) rely more on choices associated with high outcome confidence, and (c) simply repeat what they did in the past without thinking. We anticipated that participants with lowered self-control would be locked into repeating past behavior and thus their snack choices would be mediated by reports of simply repeating past behavior without thought.

To explore these various accounts of snack choice, online participants completed a depleting task or not that involved writing about their past experiences. Immediately after the writing task, all participants completed a choice task similar to Study 3 in which they selected a snack from a set of five healthful items or from a set of five unhealthful items. Our prediction of a habit boost under depletion would again emerge in a significant interaction between habit strength and depletion, with participants choosing more habitual snacks when self-control was lowered than when not.

Method

Participants

A total of 134 participants (52% women) were recruited via Amazon's Mechanical Turk to complete a study on "personality, language, and preferences." The design of the study was 2 (depletion vs. control) X 2 (healthy snacks vs. unhealthy snacks), with both factors manipulated between participants.

Procedure

All participants began the study by providing a 3-minute written description of what they did yesterday. Participants in the depletion condition were instructed to do this "without repeating any words," with the result that they had to inhibit responding with words that were accessible in memory due to their recent use. In line with prior work, inhibiting accessible responses depletes participants' self-control resources (e.g., see Pocheptsova, Amir, Dhar, & Baumeister, 2009). Participants received training by reading a sample sentence and successfully identifying two repeated words. Those in the no-depletion control condition simply wrote about their experiences without these constraints.

Immediately after finishing their description, participants were given a list of snacks and responded with the one they would like to consume right now. For half of the participants, the snack options were all healthful (yogurt, apple, celery sticks, whole wheat crackers, or almonds). For the other half of participants, the options were all unhealthful (toffee popcorn, chocolate bar, chips and salsa, cookies, or candy apples).

Measures

Perceived decision rules. After making their choices, participants rated on 5-point scales ranging from *no role* (1) to *extremely strong role* (5) the importance of each of the following decision rules in their choice: (a) *I chose the one I felt most confident about,* (b) *I chose what I normally choose when snacking and didn't think carefully,* and (c) *I went with what others would choose*.

Manipulation check. As a check on the depletion manipulation, participants rated on 7-point scales *(not at all* to *extremely*) how much they felt each of the following immediately after the writing task: (a) drained, (b) mentally exhausted, and (c) in a bad mood. In past research,

subjective fatigue and sometimes bad moods were indicators of the demands of ego-depletion tasks (Hagger et al., 2010).

Habit strength. Finally, participants rated on 8-point scales how frequently they ate each snack in their choice set, ranging from *never* (1) to *about once per day* (8). Given that they did eat a snack, they rated on a 5-point scale whether they did so in the same physical setting, ranging from *never in the same place* (1) to *always in the same place* (5). Habit strength for each snack choice was calculated as the product of the frequency and context stability measures.

Results

Manipulation Check

Demonstrating the success of the depletion manipulation, participants who wrote about their prior day without repeating any words, compared with those without this restriction, reported feeling significantly more drained (*M*s = 1.99 and 2.58, for control and depleted, respectively), $t(133) = 2.32$, $p = .022$, and mentally exhausted (*M*s = 1.94 and 2.64 for control and depleted, respectively), $t(133) = 2.55$, $p = .012$. The manipulation did not, however, increase participants' bad mood (*M*s = 1.54 and 1.52 for control and depleted, respectively), $t(133) = 0.15$, $p = .880$.

Frequency of Snack Choice

We used maximum likelihood analysis of variance (SAS PROC CATMOD) to analyze choice frequencies. Model predictors were (a) whether the participant was depleted or not (control), (b) habit strength of each snack for the participant, (c) healthfulness of the snack (healthful vs. unhealthful), and (d) all interaction terms. We estimated the model using fixed effects ($N = 134$) to allow for each participant giving multiple (5) observations. The model also included dummy variables that corresponded to the specific snack items (e.g., apple vs. not).

The analysis on likelihood of choosing a snack revealed the predicted two-way interaction between regulatory depletion and habit strength, $\chi^2(1, N = 670) = 12.79, p < .001$. Indicating that this effect of lowered willpower held for good, healthful habits as well as bad, unhealthful ones, the two-way pattern was not further moderated by healthfulness of snack, $\chi^2(1, N = 670) = 0.37, p < .546$.

To illustrate the relationship between fixed choice probabilities, depletion condition, and habit strength, we adapted Cohen et al.'s (2003) approach for use with logistic regression. We computed a logistic regression with choice versus non-choice as the dependent variable and the two-way interaction between depletion condition and habit strength and the three-way interaction between depletion condition, habit strength, and snack type (healthful vs. unhealthful) as independent variables. The estimated equation was:

Choice (1) vs. No-choice (0) = -1.6474 + .0390 (depletion condition*habit strength) - .00054 (depletion condition*habit strength*snack type)

Depletion condition was coded as 0 if not depleted and 1 if depleted. Snack type was coded as 0 if unhealthful and 1 if healthful. We calculated the choice probabilities between participants in the depleted versus not depleted conditions first for the strongest habits (40) and then for the weakest habits (1). The results indicated larger effects of depletion (vs. not) for both healthful and unhealthful strong habits, and minimal effects for weak habits (see Figures 3a and 3b). Specifically, depletion increased the probability of choosing a strongly habitual option among unhealthful snacks by 32% and among healthful snacks by 31%. In contrast, depletion increased the probability of choosing a weakly habitual option by less than 1% among both healthful and unhealthful snacks.

Depletion Did Not Boost Habits by Changing Evaluations of Snacks

To determine whether depletion shifted participants' goals or evaluations of the choices in ways that would favor more habitual options, we compared evaluations of the snacks chosen more versus less habitually when participants were versus were not depleted. That is, we constructed regression models to first predict perceived healthfulness of the snacks from habit strength and depletion and then to predict liking for the snacks from habit and depletion.

On the healthfulness rating scale, participants gave positive ratings (higher than the scale midpoint) for healthful snacks and negative ratings (lower than the scale midpoint) for less healthful snacks ($p < .001$). No other effects approached significance for healthfulness ratings. On the liking scale, participants were generally favorable toward all of the snacks, with the mean ratings for each on the positive end of the scales. Also, participants liked the snacks more to the extent that the snack was their habitually chosen option, $F(1, 469) = 367.69$, $p < .001$. Replicating Study 3, depletion did not affect liking, either as a main effect, $F(1, 469) = 1.61$, $p = .206$, or in interaction with habit strength, $F(1, 469) = 0.15$, $p = .699$. Thus, liking for strong and weak habit snack options did not change based on whether participants were depleted or not.

Mediational Analysis: Habit Boost Driven by Unthinking Repetition

In the final set of analyses, we tested the three potential psychological states that might explain how reduced willpower leads people to make more habitual choices: making the socially normative choice, making the choice associated with high outcome confidence, and (our preferred explanation) unthinkingly repeating past choices. For these analyses, we used the habit strength of a participant's chosen item as the outcome variable, and thus we used a single-level analysis. Specifically, we tested whether depletion condition influenced snack choice via each potential mediator.

Following Preacher and Hayes (2004), we conducted simple mediation analyses testing the indirect effect of depletion on habitual strength through each mediator (outcome confidence, perceived normative value of the choice, and unthinkingly choosing one's normal snack) using 1,000 bootstrap samples. Using this bootstrapping method, the effect of depletion on promoting more habitual choices was mediated by the tendency to unthinkingly choose one's normal snack (confidence interval, 0.01 to 2.04, did not include zero). In contrast, there was no evidence that this effect was mediated by outcome confidence (confidence interval, -0.95 to 0.15, included zero) or by the perceived normative value of the choice (confidence interval, -0.71 to 0.27, included zero).

As depicted in Figure 3c, the overall pattern of results suggests that depleted participants' choice of more habitual snack options was at least partially mediated by an increased tendency to unthinkingly do what one did in the past. Moreover, the effect of depletion on snack choices was not explained by rational decision making involving greater reliance on perceived norms or choices with more confident outcomes.

Discussion

This study demonstrated the habit boost effect using the two-task experimental paradigm that is standard in ego depletion research. The checks on the depletion manipulation were successful, indicating that our inhibition task of writing a description without repeating words left participants drained and mentally exhausted, similar to the tasks used in prior regulatory depletion studies.

As predicted, the lowered self-control from this depleting experience increased habitual choices during the second, snack choice task. That is, participants responded with more habitual options when selecting among apples and similar healthful snacks that would typically support

goals as well as when selecting among chocolate bars and similar unhealthful snacks that would typically conflict with goals.

This study also sheds light on the psychological mediators underlying the habit boost effect. Echoing Study 3, depletion did not alter participants' evaluations of the outcomes of their choices. That is, lowered self-control did not affect preferences for the snacks or their perceived healthfulness. Furthermore, the results of Study 4 suggested that increased habit performance under depletion was not due to rational or reflective processing, such as a greater reliance on normatively appropriate responses or responses linked with high outcome confidence. Instead, our mediation analysis indicated that depleted participants were more likely to choose habitual snacks, whether healthy or unhealthy, at least in part because they were unthinkingly repeating past choices.

Study 5

In the final study, we extended our analysis from state variations in self-control to trait-level, individual differences in self-control. To the extent that these two sources of self-control capacity function similarly, low trait control should be associated with an enduring tendency to pursue important goals by relying on stronger habits rather than weaker ones that may require the exertion of willpower. That is, just as state self-control depletion temporarily disrupts non-habits but leaves habits intact, low trait self-control may chronically limit people's ability to pursue their goals successfully through any means other than their strong habits. At the behavioral level, this implies that those with low self-control should restrict their means of goal pursuit to strong habits, whereas those with high self-control should use means of lower habit strength.

We used a standard measure of trait self-control (Tangney, Baumeister, & Boone, 2004) to predict the habit strength of the behavioral means that our college student participants used to

pursue the goal of preparing for exams. Our general prediction was that individuals with lower trait self-control would study for exams by devoting more time to behaviors that were higher in habit strength. Thus, this final study tested whether people with lower chronic self-control metaphorically place all their eggs in one basket by relying more on fewer behaviors that are stronger habits. To test this prediction, we used a multi-level regression model to examine how the second-order, person-level variable of self-control capacity moderated the first-order, individual-level relationship between habit strength of a behavioral means and the percentage of time devoted to that means.

Method

Participants

A total of 164 UCLA undergraduate students (72% women) completed the questionnaire as part of a larger survey for which participants received $20.[3]

Measures

Behavioral means. Both surveys began by asking participants to "think for a moment about the various ways that you personally…prepare for exams." They were then provided with a list of the most common behaviors generated by an earlier pilot test (N = 25) in which participants responded to the question, "how do you typically prepare for exams?" Next to each of the behaviors, participants wrote the percentage of their total exam preparation time that they

[3]In a separate study, we also assessed the relationship between habit strength and trait self-control with respect to physical exercise. However, this domain proved inappropriate to test our hypotheses because exercising was not an important goal for many of our participants and, perhaps reflecting this modest importance, trait self-control was unrelated to the frequency of exercising.

typically devoted to each of the following activities (0 - 100%): Reading over your lecture notes/textbooks repeatedly, using flash cards, writing then reading summaries/outlines of lectures or other course readings, attending a study group with friends/classmates, attending your professor/TA's office hours.

Habit strength. Using 4-point scales, participants then rated the frequency *less than once per week* (1) to *several times per day* (4) and context stability *rarely or never in the same place* (1) to *almost always in the same place* (4) with which they performed each exam preparation means. Both scales included an additional response, "not applicable, I do not typically perform this behavior," which was coded as zero. The frequency and context stability measures were multiplied to create a continuous habit strength measure (0 - 16). For each participant, a mean habit strength score was computed for the each behavior a participant indicated using at least some of the time (i.e., behaviors not given a 0% rating). By excluding individuals who provided zeros on this measure (e.g., who never used flash cards), we avoided confounding habit strength with overall baserate responding.

Goal importance. Using a 7-point scale ranging from *not at all* (1) to *extremely* (7), participants indicated how important exam preparation was to them. Overall, participants showed high levels of goal importance for doing well on exams (M = 6.48, SD = 0.80).

Trait self-control. At the conclusion of the survey, trait self-control was measured using the 36-item scale developed by Tangney et al. (2004). The scale includes items such as "I am lazy" (reverse scored) and "I never allow myself to lose control," and participants rate how much each item reflects how they typically are using a 5-point scale (*not at all* to *very much*). The scale had good reliability (α = .87). Overall, participants showed moderate levels of self-control (M = 3.22, SD = 0.45).

Results

The mean habit strength and percentage of time devoted to each exam preparation behavior are given in Table 5.

Habit Strength of Behaviors

The data were analyzed using a slopes-as-outcomes multi-level analysis (HLM; Raudenbush, Bryk, Cheong, & Congdon, 2004) in which the first analytic level included individual-level indicators of the habit strength and the percentage of time devoted to a behavior, and the second level included the person-level trait self-control strength scale. We tested whether the positive relationship between habit strength and reliance on a means was strengthened when people had lower self-control and weakened when they had higher self-control. Suggesting this pattern, the relationship between habit strength and the percentage of time devoted to a behavior was stronger for individuals lower in trait self-control than individuals high in self-control, B = -0.17, SE = 0.08, $t(162) = 2.14$, p = .034.

To decompose this interaction, we followed the procedures described by Preacher, Curran and Bauer (2006) for probing cross-level interactions in multi-level designs. Specifically, we computed simple slopes representing the relationship between trait self-control (+/-1SD) and the percentage of time devoted to a study behavior at different levels of habit (+/-1SD). As Figure 4 shows, for study behaviors that were strong habits (+1SD), trait self-control was a strongly negative predictor of the percentage of time spent on those behaviors, B = -3.25, SE = 1.22, $t(162) = 2.67$, p = .008. In contrast, for study behaviors that were weak habits (-1SD), trait self-control was not a significant predictor of the percentage of time devoted to those behaviors, B = -2.08, SE = 1.22, $t(162) = 1.71$, p = .088. Thus, as the habit strength of a study behavior

increased, participants devoted a greater proportion of their exam preparation to that behavior, but only if they possessed limited trait self-control.

Discussion

The findings from this final study using an individual difference measure of self-control capacity provided additional support for our claim that low levels of willpower encourage reliance on habitual means of goal adherence. Our college student participants with lower trait levels of self-control were more likely to pursue their educational goals with more habitual means. Thus, mirroring the effects of acute reductions in self-control, chronically low willpower appears to lock people into habit performance and impedes their ability to meet their goals through more varied and novel means. Participants with greater self-control abilities were able to pursue their educational goals with means lower in habit strength that potentially require more willpower. For example, they could study for tests by making and carrying out decisions to join study groups, using flash cards, or reviewing their lecture notes. Such behaviors lower in habit strength require exerting effortful self-control to decide on and implement (or not) desired strategies of goal pursuit.

The correlational design in Study 5 does not provide definitive evidence that trait self-control has the causal relationship to habit strength that we have described. Nonetheless, in conjunction with the prior four experiments that directly varied self-control and motivational energy, this study provides evidence that people in daily life can adhere to valued goals through habit performance.

General Discussion

In general, the present results suggest that habits are a regulatory mechanism that can enable people to engage in goal-adherent action. Across all of the five studies we report, habits

worked to compensate for low levels of self-control. Participants were especially likely to fall back on their habits when willpower was low, either because it had been reduced through prior self-control efforts (Studies 1 – 4) or because it was chronically limited (Study 5). This reliance on habits promoted goals when the habitual behaviors were goal-congruent, but was detrimental to goal pursuit when habits were goal-incongruent.

It might seem surprising that people fall back on good habits when their willpower is low. Bad habits such as nail biting, over-eating, and drug addictions are well-known to challenge goal pursuit, but little research has explored performance of good habits. A principled application of automaticity would anticipate both effects. With limits in willpower, people have difficulty inhibiting cognitively accessible responses and deliberating about alternative courses of action. Although people typically do not want to alter their good habits in these ways, they sometimes seek variety and adjust their behavior to their present circumstances and interaction partners. Thus, the boost in good habit performance has its roots in the limited capacity of willpower and the tyranny of automaticity that are already known to increase bad habits. In the case of good habits, however, these same processes provide people with a pathway to actually improve goal adherence when they lack self-control.

The studies we report used a variety of procedures to reduce self-control and motivational energy, including taking exams, inhibiting use of the dominant hand in everyday tasks, inhibiting repeated word use in a writing task. Although each of these procedures might have unique features that could influence responding, the common effect of boosting habits that emerged with all of these experimental variations is reassuring in tying our findings to limitations in self-control. In general, we suspect that any factor that limits deliberative responding will boost habits by reducing the capacity to inhibit the dominant response and choose an alternative one.

Thus, increased stress caused by a performing a cold pressor test under social evaluation promoted habit performance at an instrumental task (Schwabe & Wolf, 2009). Also, low ability to engage in high-level reasoning in a given task may promote reliance on habits (Marchette, Bakker, & Shelton, 2011). However, as we noted in Study 1, other factors that reduce deliberative responding, such as time pressures, can have additional effects beyond boosting habits. With limited time, our participants were less able to perform time-consuming activities that could include strong habits. Thus, time pressures might increase performance of habits that do not require much time for preparation or performance, but not habits that are highly time-consuming.

In our analysis, the difference between good and bad habits lies in the relation between habits and currently pursued goals. "Good" habits promote current goals and "bad" habits impede them. Presumably, most habits were formed initially because they promoted goals—people are likely to repeat behaviors in stable contexts when the behavior generates desired outcomes. To the extent that goals remain stable, such habits should remain goal-congruent. The congruence between habits and goals is further promoted by people's interpretations of their motivations for responding (Neal et al., 2012). For example, people might interpret the fluency of habit performance as liking for the response and outcome, or they might follow a self-perception process and infer that they must intend to perform a behavior that they repeat so often. Given stability in goals and these interpretational processes, many everyday habits are congruent with people's goals (Ouellette & Wood, 1998).

People nonetheless are likely to be more aware of their bad than good habits simply because bad habits are so challenging to control (Baumeister & Heatherton, 1996). A large amount of effort, time, and money is spent trying to change unwanted habits into more healthful,

economical, and productive behaviors. Bad habits seem to take on a life of their own and to persist despite people's best efforts at change. We believe that this force reflects automatic cuing by contexts, and it differs from the mechanisms by which temptations challenge goal pursuit. The impetus behind temptations comes from positive, short-term visceral responses (Lowenstein, 1996; Metcalfe & Mischel, 1999). In evidence of these different types of automaticity, Quinn, Pascoe, Wood, and Neal (2010) demonstrated that distinct forms of willpower are required to control unwanted habits as compared with affective temptations. Although bad habits and temptations both challenge goal pursuit, they have unique patterns of influence, with habits being activated by the cues associated with performance in the past and less by affective reactions.

In Study 2, we were able to evaluate the overall success of goal-adherence with the 12 or so behaviors that participants nominated as relevant to achieving their goals. Although our measure did not include every behavior in which participants were engaged, we could track the ones that participants personally nominated as involved in goal pursuit. Based on this measure, participants were almost as successful at goal adherence on days with lowered self-control compared with other days. However, the processes by which participants achieved their goals seem to have varied on these days. When self-control was reduced, participants apparently met their goals through increased performance of good habits, although also suffering the effects of increased performance of bad ones. On other days, they were less successful at implementing good habits, but were also less apt to succumb to bad habits. Thus, the overall ratio of goal congruent to incongruent behaviors did not change as a function of lowered self-control; only the ratio of habitual to non-habitual behaviors changed. This overall pattern by which people fall back on automatic forms of goal adherence when willpower is low may help to explain the paradox by which people's motivational energy is easily sapped by depletion manipulations

(Haggar et al., 2010), yet people still are relatively successful in daily life at achieving many goals.

Conclusion

Habits have been largely overlooked in classic models of self-regulation that emphasize how people tailor their behavior to reach desired goals and standards and to avoid undesired ones (e.g., Carver & Scheier, 2008; Miller, Galanter, & Pribram, 1960). The present findings suggest that self-regulation proceeds through a variety of interrelated processes and does not conform to a one-size-fits-all model. Each type of regulation has characteristic features that are suited to particular circumstances. Active self-control mechanisms guide behavior flexibly, yet motivational and cognitive resources are required to exert willpower. Habits are triggered automatically but reproduce past responding with limited sensitivity to shifting goals. These various regulatory mechanisms, in conjunction with additional ones not addressed in the present research (e.g., Trope & Fishbach, 2000), work together to enable successful goal adherence in a broad range of contexts.

Our focus in the present research has been to understand how habits augment and challenge classic mechanisms of self-regulation. In addition, research on habits can contribute to understanding of regulatory mechanisms. For example, habits offer an alternative account of the effects of practice on success at self-regulation. Muraven and Baumeister (2000) proposed that individuals get better at regulating with practice because practice increases the capacity for self-control and in the long run provides people with a larger reserve of regulatory resources on which to draw. However, practice of a behavior also automates response performance and outsources regulation to environmental cues. Thus, once responses become habitual, performance can be regulated without requiring as much self-control.

Understanding habits is important for many lifestyle interventions, such as those to increase healthful eating, exercise, and energy conservation (e.g., Rothman, Sheeran, & Wood, 2009; van't Riet et al., 2011). Given that willpower is often limited, our results suggest that implementing healthful and environmentally-sustainable lifestyles may require more than just appropriate goal setting and more than just effective habit formation. Instead, interventions may need to consider how these factors interact with each other differently, depending on the vagaries of self-control in daily life. For example, interventions aimed to promote performance of existing healthful habits (e.g., recycling, exercise) might take advantage of contexts in which people's self-control is likely to be lower. In contrast, interventions designed to disrupt existing bad habits (e.g., fast food consumption, smoking) should take advantage of settings where self-control is likely to be higher. In these ways, people's behavior change efforts can be better tailored to the underlying mechanisms of self-regulation and goal pursuit (Nilsen, Roback, Broström, & Ellström, 2012; Verplanken & Wood, 2006).

Author Notes

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Table 1. Mean Frequency of Performance during Exam and Nonexam Weeks and Mean Habit Strength: Study 1

	Mean frequency of performance (SD)		Mean habit strength (SD)
	Exam week	Nonexam week	
Desirable, goal-congruent behaviors			
Eating cold cereal	.08 (.35)	.06 (.25)	0.99 (0.56)
Eating hot cereal	.44 (.73)	.24 (.49)	1.40 (0.77)
Eating health bar	.11 (.35)	.32 (.52)	0.26 (0.56)
Reading local news	.12 (.44)	.08 (.27)	0.27 (0.74)
Reading world news	.14 (.44)	.11 (.39)	0.16 (0.54)
Reading editorial page	.28 (.65)	.17 (.45)	0.51 (0.91)
Reading comics	.01 (.12)	.23 (.45)	0.10 (0.35)
Undesirable, goal-incongruent behaviors			
Eating pastry	.38 (.70)	.25 (.44)	0.79 (1.03)
Eating pancakes/French toast	.07 (.34)	.12 (.37)	0.16 (0.51)
Drinking mocha/frappuccino	.10 (.30)	.09 (.29)	0.20 (0.51)
Using sugar in coffee	.12 (.33)	.11 (.31)	0.34 (0.63)
Using half and half in coffee	.19 (.49)	.23 (.58)	0.23 (0.67)
Reading advice column	.65 (.88)	.32 (.50)	0.99 (1.18)
Reading business section	.03 (.16)	.31 (.49)	0.24 (0.71)

Note. Participants reported performing or not a given behavior on a given day across each 2-week period (ranging from 0 to 2 times). Habit strength was calculated from self-reports of

typically performing a behavior plus performance across the first two study weeks (ranging from 0, nonhabit, to 3, strong habit).

Table 2. Test Statistics and Mean Square Errors from Regression Models Predicting Frequency of Performance for Strong and Weak Habits during Exam and Nonexam Weeks: Study 1

	F for interaction between exam week and habit strength (*p* value)	MS_{error}
Desirable, goal-congruent behaviors		
Eating cold cereal	6.37 (.01)	0.03
Eating hot cereal	4.10 (.05)	0.31
Eating health bar	2.04 (.16)	0.37
Reading local news	53.93 (.001)	0.05
Reading world news	0 (*ns*)	0.15
Reading editorial page	1.19 (.28)	0.17
Undesirable, goal-incongruent behaviors		
Eating pastry	7.38 (.009)	0.39
Eating pancakes/French toast	3.18 (.08)	0.24
Drinking mocha/frappuccino	0.93 (.34)	0.09
Using sugar in coffee	4.62 (.04)	0.12
Using half and half in coffee	5.91 (.02)	0.15
Reading advice column	19.66 (.001)	0.33

Note. Regression models predicted performance (ranging from none to twice) during exam vs. no-exam week (as a repeated predictor) and from habit strength to perform that behavior.

Table 3. Mean Performance Likelihood, Habit Strength, and Goal Instrumentality for Goal-Congruent and -Incongruent Behaviors: Study 2.

	Mean likelihood of performance each day of study	Mean habit strength	Mean perceived importance of behavior in helping or hindering goal pursuit
Goal-congruent behaviors	56%	12.72 (2.66)	5.80 (1.01)
Goal-incongruent behaviors	50%	12.25 (3.31)	5.57 (1.26)

Note. Greater likelihood reflects more frequent performance across the four study days. Also, higher numbers reflect stronger habits and, on a 7-point scale, greater importance of a behavior in helping or hindering goal pursuit. Standard deviations in parentheses.

Table 4. Mean Choice Frequencies and Perceptions for Snack Items: Study 3

	Frequency of choice	Liking	Rated healthfulness	Habit strength
Healthful snack selection				
Protein snack	23.33 (42.65)	2.39 (4.00)	5.02 (1.86)	3.51 (2.05)
Fruit	21.67 (41.54)	4.76 (1.97)	6.25 (1.03)	5.25 (1.61)
Yogurt	53.33 (50.31)	3.10 (2.75)	4.35 (1.53)	3.70 (1.64)
Low fat whole wheat crackers	1.67 (12.91)	1.14 (2.67)	2.86 (2.05)	2.98 (1.53)
Unhealthful snack selection				
Popcorn treat	25.00 (43.67)	1.70 (3.62)	-2.54 (2.19)	2.24 (1.56)
Mini milk chocolates	10.00 (30.25)	3.59 (2.77)	-3.19 (2.85)	3.27 (1.87)
Fun-size Snickers™	31.67 (46.91)	2.76 (3.67)	-3.71 (2.95)	3.02 (1.87)
Sugar cookies	33.33 (47.54)	1.78 (2.83)	-3.14 (2.34)	2.31 (1.53)

Note. Mean choice frequencies were scored 100% for the chosen item and 0% for the nonchosen ones. Liking was assessed on a -7 to +7 scale, with higher numbers reflecting greater liking. Healthfulness was assessed on a -7 to +7 scale with higher numbers reflecting good for health. Habit strength was calculated to reflect past frequency and stability of context. Standard deviations given in parentheses.

Table 5. Mean Percentage of Time Used and Habit Strength for Studying: Study 5

Behavioral means	Mean percentage of time each means used (*SD*)	Mean habit strength of each means used (*SD*)
Reading over lecture notes/textbooks	47% (23.26)	20.13 (3.25)
Using flash cards	6% (9.62)	15.90 (4.81)
Writing summaries/outlines	26% (20.65)	19.26 (3.30)
Attending study group	13% (14.07)	14.36 (4.59)
Attending instructor office hours	8% (7.43)	16.68 (4.40)

Note: The percentage of time devoted to each behavioral means was estimated out of 100% total. Habit strength represents the frequency and context stability with which participants used each means.

Figures 1a and 1b: Study 2.

Decomposition of 2-way interaction predicting likelihood of performing behaviors congruent with goals (Figure 1a) and behaviors incongruent with goals (Figure 1b). Simple slopes depict performance on depleted and non-depleted days for strongly habitual behaviors (mean + 1SD), moderately habitual behaviors (mean), and weakly habitual behaviors (mean - 1SD). Slopes control for compliance with the depletion manipulation and strength of handedness.

Figures 2a and 2b: Study 3

Decomposition of 2-way interaction predicting snack choice for healthful snacks (Figure 2a) and unhealthful snacks (Figure 2b). Simple slopes depict likelihood of choosing a snack as a function of the habit strength of that choice (frequency and context stability of past consumption) and whether the participant was depleted or not when choosing.

Figures 3a and 3b: Study 4

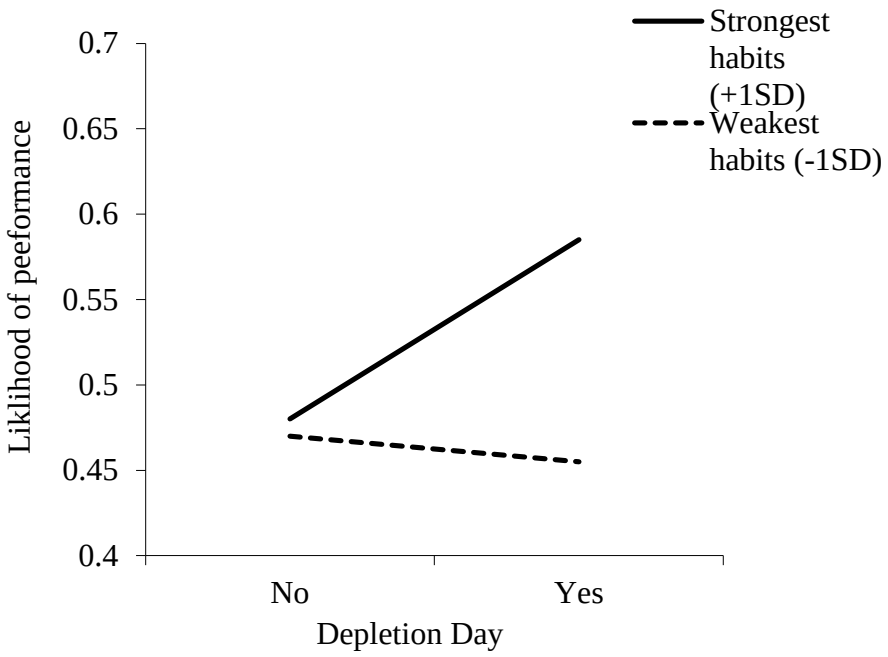
Decomposition of 2-way interaction predicting snack choice for healthful snacks (Figure 3a) and unhealthful snacks (Figure 3b). Simple slopes depict likelihood of choosing a snack as a function of the habit strength of that choice (frequency and context stability of past consumption) and whether the participant was depleted or not when choosing.

Figure 4: Study 5

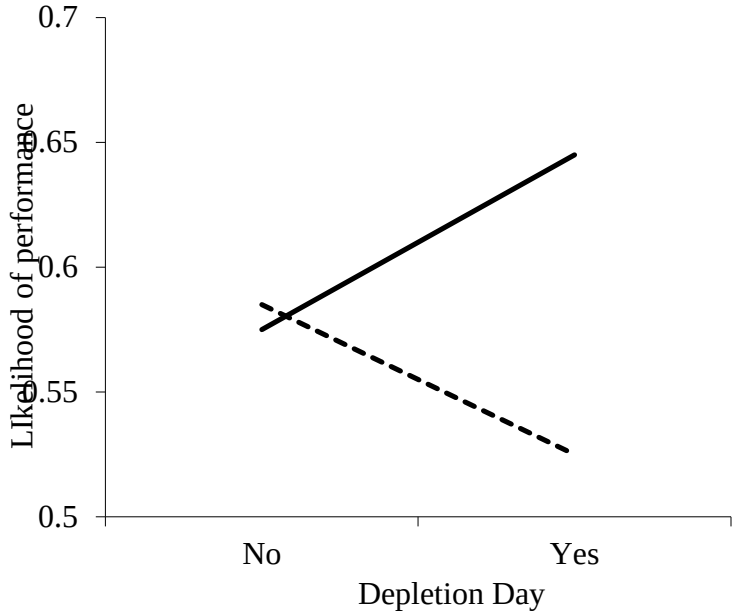
Decomposition of 2-way interaction predicting the percentage of time participants devote to each of five exam preparation behaviors. Simple slopes depict the percentage of time spent as a function of the of the habit strength of that choice (frequency and context stability of past

performance) and whether the participant had low versus high trait self control.

Figure 1a and 1b

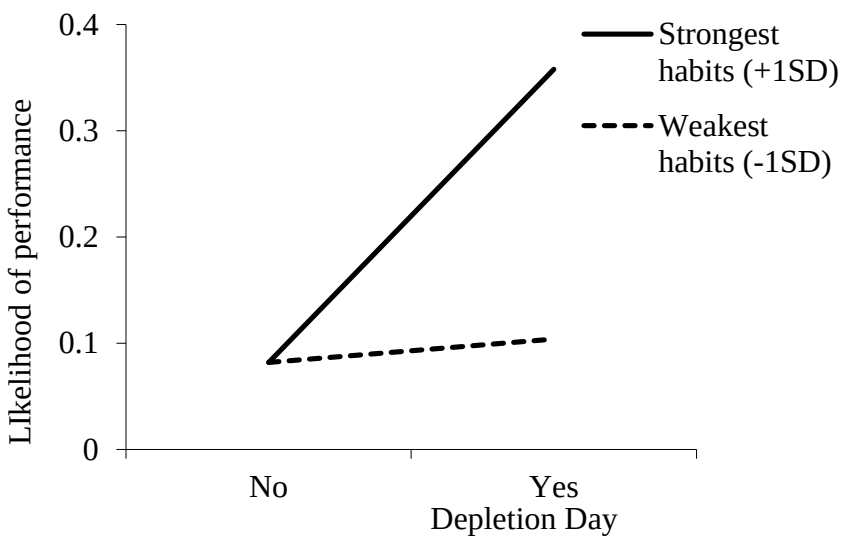


Behaviors Incongruent with Goals

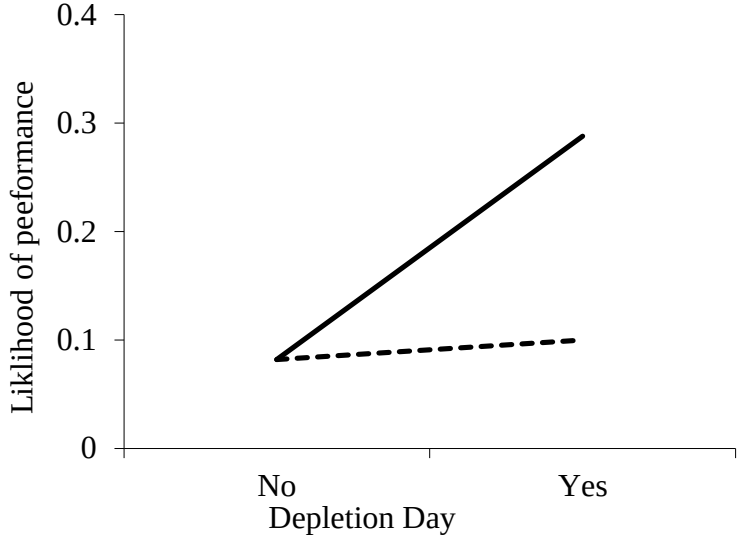


Behaviors Congruent with Goals

Figures 2a and 2b

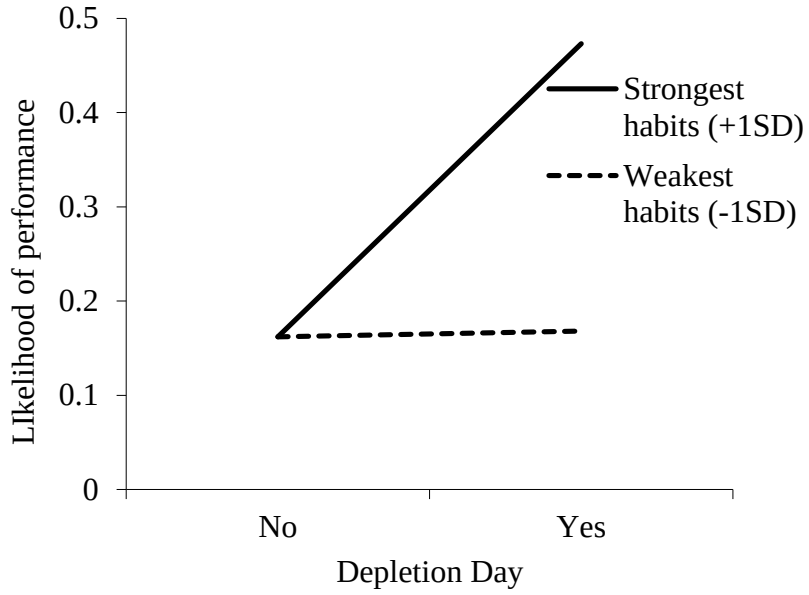


Healthful Snacks

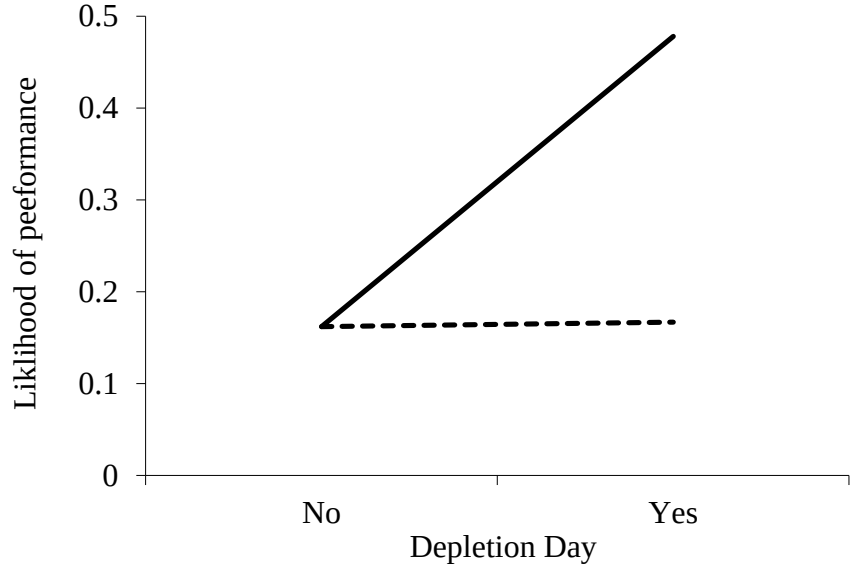


Unhealthful Snacks

Figures 3a and 3b

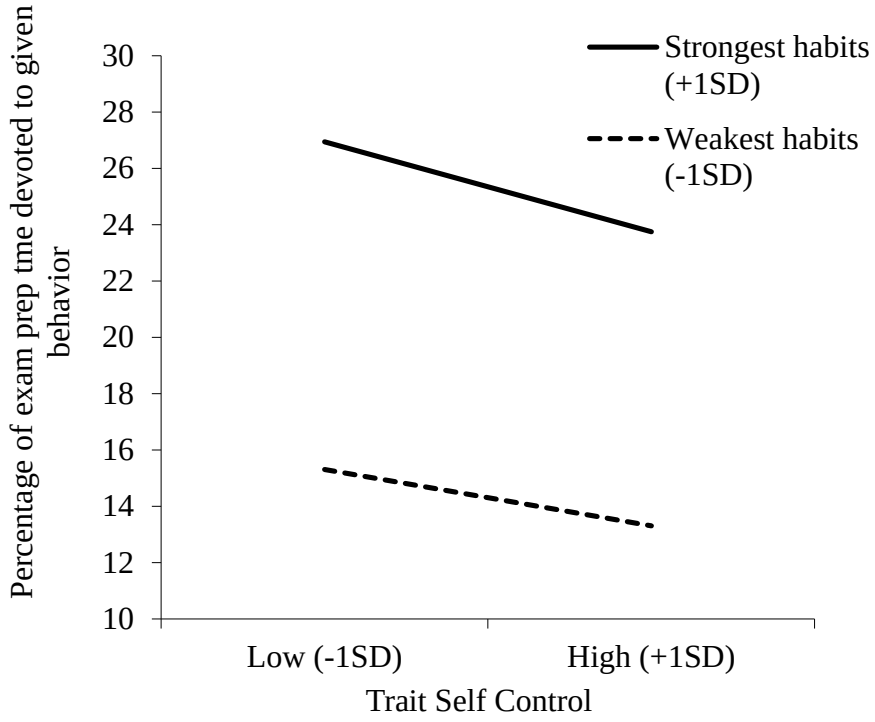


Healthful Snacks



Unhealthful Snacks

Figure 4


Percentage of exam prep tme devoted to given behavior
30
28
26
24
22
20
18
16
14
12
10
Strongest habits (+1SD)
Weakest habits (-1SD)
Low (-1SD)
High (+1SD)
Trait Self Control