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The Self-Control Costs of Fighting the Temptation to Drink

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Being exposed to the sight and smell of an alcoholic beverage and not drinking it should require self-control. On the basis of the self-control strength model (M. Muraven & R. F. Baumeister, 2000), exerting self-control should lead to poorer performance on subsequent self-control tasks. Using a cue exposure paradigm, the authors had 160 social drinkers alternately sniff water and alcohol. After each trial, the drinkers engaged in 2 self-control tasks: squeezing a handgrip and a self-stopping task. Performance on these tasks was worse after sniffing alcohol than after sniffing water. Mood and arousal did not mediate the effects; urge to drink was negatively related to outcomes. The effects were stronger for individuals high in trait temptation to drink. Resisting the temptation of drinking appears to undermine self-control capacity.

Keywords: self-control, restraint, alcohol, cue exposure

Being exposed to alcohol cues should be very demanding for heavy drinkers who are trying not to drink. On the basis of the principles of classical conditioning, the sight, smell, or taste of alcohol should elicit a conditioned urge to drink alcohol (e.g., Rohsenow, Niaura, Childress, Abrams, & Monti, 1990–1991). Hence, heavy drinkers who are exposed to drinking cues (such as the person seated next to a heavy drinker on an airplane ordering a drink) and who wish to restrain or limit their drinking (to remain clearheaded for a meeting after the plane lands) must exert great effort to overcome the conditioned response of drinking (Brown, 1998). Furthermore, resisting temptations may be costly, as it depletes a limited resource needed for self-control, resulting in poorer self-control performance subsequently (e.g., Muraven & Baumeister, 2000).

Self-control involves the overriding or inhibiting of behaviors, urges, or desires that would otherwise interfere with goal-directed behavior (Barkley, 1997; Baumeister, Heatherton, & Tice, 1994; Shallice & Burgess, 1993). People exert self-control to follow a rule (either externally or internally determined) or to delay gratification (Barkley, 1997; Hayes, Gifford, & Ruckstuhl, 1996). Without self-control, the individual would carry out his or her normal, typical, or automatic behavior. For instance, when tempted to drink, individuals trying to restrain their drinking who fail to exert sufficient self-control to overcome their urge to drink may lose control and drink the alcohol.

Self-Control Strength

Overriding ones' urges or habits may have a cost. The costs of self-control may help to explain why self-control frequently fails and why individuals restraining their alcohol intake report that overcoming the temptation to drink requires a great deal of effort. In particular, we have theorized that self-control requires a limited resource, *self-control strength*, which is required for and is consumed in the process of all acts of self-stopping (Muraven & Baumeister, 2000; Muraven, Tice, & Baumeister, 1998). In particular, the model of self-control strength predicts that (a) self-control strength is necessary for all attempts at self-control. Regardless of what is being regulated, self-control involves the inhibition of an impulse, urge, or desire, and this inhibition requires the use of self-control strength. (b) The exertion of self-control reduces the amount of strength available to the individual for a short time. The magnitude and duration of the decline in self-control strength should be proportional to the degree of self-control required. (c) The success of self-control is partially related to the individual's level of self-control strength. Individuals whose self-control strength has been depleted should be more likely to suffer a breakdown in subsequent self-control performance.

Consistent with the predictions made by this strength model, individuals who engaged in self-control tended to perform more poorly on subsequent tests of self-control compared with individuals who worked on an equally frustrating, arousing, and absorbing task that did not require self-control (Baumeister, Bratslavsky, Muraven, & Tice, 1998; Muraven et al., 1998). Furthermore, the effects of exerting self-control are specific to tasks that require self-control. Tasks that require minimal self-control but are sensitive to motivation (e.g., typing or sorting cards) are not affected by the prior exertion of self-control (Baumeister et al., 1998; Muraven & Slessareva, 2003). In conclusion, research on self-control strength suggests that overriding or inhibiting a behavior reduces the available amount of self-control strength, thereby impairing self-control performance.

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Self-Control and the Regulation of Alcohol Intake

Drinking restraint involves a conflict between the individual's urge to drink and his or her resistance to these impulses (Bensley, 1989; see also Polivy, 1990). When the strength of the urge to drink exceeds an individual's ability to restrain him- or herself, violation of drinking limits is likely to ensue (Collins, 1993). Evidence from social drinkers supports this conclusion: Social drinkers who are both high in urge to drink and high in restraint drink less than social drinkers who are high in urge to drink and low in restraint (see also Bensley, 1991; Collins & Lapp, 1992). More specifically, nonautomatic processes must be used to alter and inhibit well-learned cognitive and behavioral patterns that link situations or emotions with drinking (Tiffany, 1990). In this model, self-control is critical to regulating intake and not drinking to excess (e.g., Brown, 1998; Hodgson, 1989; Marlatt & Parks, 1982).

Individuals with weaker inhibitions therefore should be more likely to violate their drinking limits compared with individuals with stronger self-control. Indeed, social drinkers whose self-control ability was weakened through the depletion of self-control strength drank more alcohol and had higher blood alcohol levels in a situation that called for restraint than did social drinkers who did not exert self-control (Muraven, Collins, & Nienhaus, 2002). This is further supported by research on underage drinkers as they went about their daily lives (Muraven, Collins, Shiffman, & Paty, 2005)

Although the depletion of self-control strength may lead to a greater risk of violating drinking limits, the converse also may be true: Sticking to drinking limits may lead to the depletion of self-control strength. Heavy drinkers who restrain their urge to drink may have less self-control strength than heavy drinkers who do not restrain themselves. Therefore, heavy drinkers who have to fight the urge to drink may perform more poorly on subsequent tests of self-control compared with drinkers who do not have to fight the urge to drink.

Cue Exposure and Subsequent Self-Control Performance

In the present study, these ideas were tested using a cue exposure paradigm. On the basis of theories of automaticity, drinking cues should trigger the intention to drink in heavy drinkers (Tiffany, 1990). Indeed, heavy drinkers who are exposed to drinking cues responded to those cues with increased urge to drink (Cox, Yeates, & Regan, 1999; Greeley, Swift, Prescott, & Heather, 1993). In these experimental situations, the participants do not drink, however (e.g., Cooney, Litt, Morse, Bauer, & Gaupp, 1997). Overriding an urge to drink produced by exposure to a tempting substance likely requires the individual to exert self-control, which should lead to a loss of self-control strength.

In summary, resisting the temptation of an addictive cue may impair subsequent self-control performance. More specifically, the effects of resisting temptation on subsequent performance should be driven by the amount of self-control required; individuals' urge to drink should be related to self-control outcomes above and beyond the effects of mood or arousal. The act of self-control is what should produce the decline in performance. Moreover, the effects of resisting a temptation should be specific to tasks that require self-control, so that performance on tasks that do not require self-control should be unaffected by fighting a temptation.

Method

Participants

The sample consisted of 160 (63 female and 97 male) social drinkers. Participants were social drinkers in the Albany, New York, area who responded to advertisements for a study on alcohol consumption. They completed a phone interview, and those who were eligible were scheduled to participate in the study. To be eligible for the study, participants had to be between the ages of 21–45 to ensure legal drinking age ($M = 27.03$, $SD = 7.46$), drink a minimum of one drink a week (self-reported $M = 9.01$, $SD = 9.51$, range = 1–50), and have no previous medical diagnosis or treatment for alcohol abuse. Participants who scored greater than two on the Short Michigan Alcohol Screening Test (SMAST; Selzer, Vinokur, & Rooijen, 1975) were also excluded. Furthermore, they could have no medical contradictions to alcohol use, including pregnancy or plans to become pregnant, and had to have at least an 8th-grade education because of the quantity and level of the questionnaires. Participants could not be taking an anticraving medicine or other medicines that may affect desire to drink. Anyone who reported a serious mental illness (e.g., schizophrenia, severe depression) was also excluded.

The majority of participants (83.2%) indicated a European American background, and the remainder were primarily African American (6.2%) and Asian American (3.1%). The majority of participants (71.4%) were employed at least part time, and 36% were in school at least part time. Participants had their first drink of alcohol at 15.34 years ($SD = 8.55$) and began drinking regularly at 18.97 years ($SD = 9.33$). About a third of participants (36.6%) reported a family history of alcohol problems.

Procedure

Overview. Participants were asked to sniff alcohol or water (the order of tasks was counterbalanced). They then engaged in two different self-control tasks (stopping themselves from responding when a tone sounded and squeezing a handgrip as long as possible). Their mood, arousal, and urge to drink were then assessed. Following this procedure, they sniffed the other beverage and engaged in the same two self-control tasks.

Recruitment and initial screening. Participants were recruited using local newspaper advertisements and flyers. They called a telephone hotline to be screened for eligibility. If they met the requirements of the study, they were scheduled to come to the Self Control in Life lab at the University at Albany. The experimenter explained that the purpose of the experiment was to study how exposure to various substances affects performance and that the study would involve several tasks as well as various questionnaires assessing demographic information, drinking behavior, and attitudes. Each individual testing session lasted approximately 90 min, and participants were paid $30 for their participation. All participants were tested between 2 p.m. and 7 p.m. by the same experimenter. Before starting the experiment, participants signed an informed consent, and their blood alcohol concentration was measured using an alcohol breath analyzer (Intoxilyzer; CMI, Owensboro, KY).

Before the cue exposure paradigm, participants completed a demographic questionnaire that included information about drinking behaviors (e.g., typical weekly consumption of alcohol, family history of alcohol) and attitudes toward alcohol. The scale also measured typical use of drugs other than alcohol. Participants also completed the Temptation and Restraint Inventory (TRI; Collins & Lapp, 1992). This 15-item scale assesses trait levels of temptation to drink and the tendency to control drinking. Responses were made on a 9 point-scale from 1 (*never*) to 9 (*always*). The TRI has five factors, which combine to form two higher order factors: Cognitive and Emotional Preoccupation (TRI-CEP; temptation to drink) and Cognitive and Behavioral Control (TRI-CBC; restraint of drinking). Consistent with previous research (e.g., Collins, Koutsky, & Izzo, 2000), in the present study, the TRI-CEP correlated with average weekly consumption of alcohol, alcohol binges per week, SMAST score, negative sequelae of drinking (e.g., hangovers), and problems with alcohol. Because we were primarily interested in how resisting the temptation to drink alcohol relates to subsequent self-control outcomes, we focused on the TRI-CEP factor.

Cue exposure. After completing the preexperimental questionnaires, participants began the cue exposure phase of the study, consistent with the standard cue reactivity assessment used in similar studies (Monti et al., 1993; Stasiewicz et al., 1997). Participants were exposed to water and alcohol (the order of exposure was counterbalanced across participants). A glass with either water or the participant's usual alcoholic beverage (assessed during the screening) was placed next to the participant's dominant hand. Participants then listened to a 4-min prerecorded tape with a series of bell rings (the duration between rings varied, with a mean of 15 s). Every time the bell rang, the participants were to lift the glass and smell the beverage for a few seconds before putting the glass back down. Participants were asked to monitor and think about the temptation involved in resisting the drink, in order to increase the self-control demands of the task. In a deviation for standard cue exposure instructions, participants were strongly encouraged to not drink the beverage but were told, "If you find it impossible to resist, then you can drink it. The idea is to resist if you can." No participant drank. Immediately after each cue exposure trial, participants completed three questionnaires.

Alcohol-Urge Questionnaire (Bohn, Krahn, & Staehler, 1995). This 8-item scale was used to assess participants' urge to drink (e.g., "All I want to do now is have a drink"). Responses were made on a 7-point scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). The scale has excellent internal reliability in the present study ($\alpha = .91$ after alcohol, $\alpha = .93$ after water). Furthermore, the Alcohol-Urge Questionnaire has been demonstrated to be related to cognitive preoccupation with alcohol ($r = .42$) and alcohol dependence ($r = .21$).

Brief Mood Introspection Scale (BMIS; Mayer & Gaschke, 1988). The BMIS is a 16-item scale used to assess participants' mood and arousal. The scale loads on two factors: valence (pleasantness–unpleasantness) and arousal (aroused–calm). Items consist of 16 adjectives depicting various mood states (e.g., *happy*, *frustrated*), and responses are marked on a 7-point scale ranging from 1 (*definitely do not feel*) to 7 (*definitely feel*). The BMIS has good internal consistency (arousal after water: $\alpha = .68$; mood after water: $\alpha = .86$; arousal after alcohol: $\alpha = .67$; mood after alcohol: $\alpha = .85$).

Cue exposure manipulation check. The manipulation check consisted of nine questions designed for this experiment to assess interest, difficulty, and pleasantness of the task. Of particular interest, we assessed how much participants reported having to fight against the urge to drink the beverage. Items were measured on a 30-point response continuum ranging from 1 (*not at all*) to 30 (*very much*).

After participants completed the three questionnaires, we assessed participants' self-control capacity using two behavioral measures: a computerized self-stopping task and a physical handgrip measure. The order of these two measures was counterbalanced.

Self-stopping task. The stop signal task is a self-stopping cognitive test of inhibition that requires participants to respond as quickly as possible to a judgment task (de Jong, Coles, Logan, & Gratton, 1990; Logan, 1994). Specifically, participants were instructed to locate the position of a white square that appeared on the screen, relative to an initial fixation point. If the square appeared on the right of that point, they were to press the question mark key (*?*) on the keyboard, and if the square appeared on the left, they were to press the *z* key. Participants were asked to respond as quickly and accurately as possible. On 25% (16 out of 64) of the trials, a tone sounded, indicating that participants should inhibit their response. That is, if they heard the tone, they should not hit any key on the keyboard when the square appeared. Previous research has found that performance on the stop signal task is positively related to self-control capacity (Muraven, Shmueli, Slessareva, & Burkley, 2006).

All participants received standard instructions that appeared on the screen and that were read to each participant by the experimenter. The task was composed of five blocks, each consisting of 64 trials, with a short break between blocks. Consistent with previous work with the stop signal, participants' mean primary reaction time (i.e., how quickly they responded to the square) was recalculated within the stop signal program on each trial. The auditory stop signal tones were then presented 50, 200, 350, and 500 ms before the mean primary reaction time calculated in the preceding blocks. Mean reaction time was used to ensure that the difficulty of the task was similar for each participant (rather than using fixed times, which would not control for individual differences in overall reaction time). The signal tones were counterbalanced across right and left presentation of the square, and presentation of 50-, 200-, 350-, and 500-ms trials was randomized within each block. The number of correct responses (no key hits when the tone sounded) was the outcome of this measure (minimum of 0, maximum of 80).

Handgrip task. Participants were instructed to squeeze a handgrip exerciser and try to maintain their grip for as long as they could. The handgrip exerciser is a commercially available device used for developing physical strength in the hands and consists of two handles connected by a metal spring. Previous research has suggested that handgrip squeezing duration (correcting for physical strength) is strongly related to performance on other tasks that require self-control (Rethlingshafer, 1942; Thornton, 1939). Moreover, the handgrip measure has been used successfully in previous self-regulation research (Muraven et al., 1998). Because squeezing the handles is tiring for the hand muscles, participants must exert self-control in order to overcome the urge to release the grip. In particular, individuals higher in self-control capacity should be able to hold the handgrip longer than individuals low in self-control capacity. A small wad of paper was inserted between the handles, so that when participants' grip relaxed, the wad would fall, indicating the release of the handgrip.

Results

Response to Alcohol and Water

Analysis of participants' reports of their urge to drink after sniffing alcohol and water indicated, as expected, that the urge to drink the beverage was stronger after exposure to the alcohol ($M = 29.0$, $SD = 14.3$) than after exposure to the water ($M = 24.9$, $SD = 12.2$), $t(158) = 3.29$, $p < .001$. The self-reported urge to drink after sniffing alcohol correlated significantly with both temptation to drink (TRI-CEP), $r(159) = .51$, $p < .001$, and trait restriction (TRI-CBC), $r(159) = .255$, $p < .001$. In other words, the urge to drink was stronger after sniffing alcohol than after sniffing water, and that urge was stronger for individuals who drank more on average. The results also indicate that the stronger the urge, the more effort participants reported exerting at resisting the temptation, $r_{water}(158) = .65$, $p < .001$, and $r_{alcohol}(158) = .68$, $p < .001$.

For these and all subsequent analyses, there was no main effect for order (e.g., sniffing water first vs. sniffing alcohol first and squeezing handgrip first vs. stop signal first) nor did it interact with any variable in a meaningful way, except where noted. Hence, the different order of tasks was pooled in the analyses. Similarly, there were no main effects or meaningful interactions with demographic variables (e.g., age, gender, ethnicity), except where noted, so analyses were not separated by subgroup.

Stop Signal

As shown in Figure 1, after sniffing alcohol, individuals made more incorrect responses on the stop signal (i.e., they hit the key more when the tone sounded) compared with after sniffing water. This was true for all four stop signal intervals, multivariate F(1,

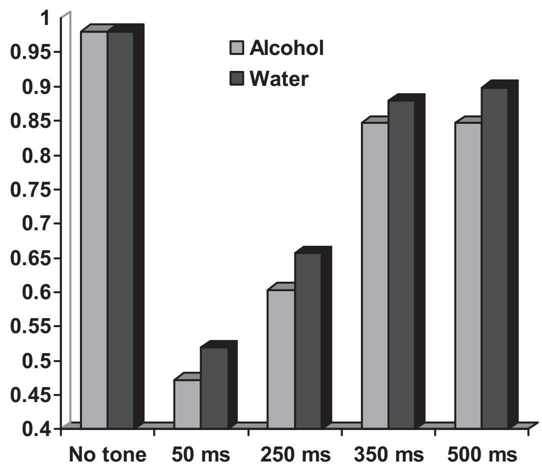

Figure 1. Percentage of responses inhibited on stop signal task after sniffing alcohol and water based on the interval of the stop signal tone before mean reaction time. No tone trials reflect percentage of correct responses.

153) = 18.6, $p < .001$. Although there was a significant difference in performance at each stop signal tone interval, multivariate $F(1, 151) = 191$, $p < .001$, tone interval did not interact with sniffing trial, multivariate $F(3, 151) = 0.387$, *ns*. On the other hand, if trials in which the tone did not sound were considered as well, there was a significant multivariate interaction between stop signal interval and trial, multivariate $F(4, 150) = 4.23$, $p < .005$. Paired *t* tests indicated that on trials in which the tone did not sound, participants' performance was the same after sniffing alcohol and sniffing water, $t(155) = 0.853$, *ns*. On trials in which the tone did sound, participants were less able to stop themselves from hitting the key after sniffing alcohol than after sniffing water, all $ts(155) > 2.18$, $ps < .025$. Quite simply, on tasks that do not require self-control (indicating whether a box appears on the left or right side of the screen), performance is unaffected by sniffing alcohol. Only when the task requires self-control (preventing oneself from responding) is performance affected by sniffing alcohol.

In order to simplify the subsequent analyses, we combined participants' performance (number of presses when tone sounded) on the four stop signal intervals. The resultant scale had a coefficient alpha of .79 (after sniffing water) and .76 (after sniffing alcohol). The results discussed below were largely the same when each stop signal interval was considered separately.

Using multiple regression, we examined how participants' performance on the stop signal task was related to their urge to drink the beverage, mood, and arousal. As shown on Table 1, urge to drink the alcohol predicted stop signal performance above and beyond the effects of mood and arousal, $\Delta R^2 = .029$, $F(1, 153) = 4.86$, $p < .05$. Indeed, performance on the stop signal task was unrelated to mood and arousal but was related to urge. The results indicate that the stronger the urge to drink the alcohol, the more self-control is likely required to not drink it. Thus, their depleted self-control strength resulted in impaired performance on the stop signal task.

Stop signal performance after sniffing water was similarly unrelated to mood and arousal. Unlike after sniffing alcohol, self-reported urge to drink the water after sniffing water was unrelated to stop signal performance. The addition of the urge term did not lead to significant change in the model, $\Delta R^2 = .014$, $F(1, 153) = 2.18$, *ns*, and the overall model was not significant, either.

When effort exerted fighting the temptation to drink was considered instead of urge, the correlation between participants' self-reported effort exerted not to drink and stop signal performance was significant, $r_{water}(158) = -.15$, $p < .05$, and $r_{alcohol}(158) = -.16$, $p < .05$. This further supports the idea that performance on the stop signal task is related to how hard participants worked at not drinking the beverage.

Finally, whether participants' trait temptation to drink (TRICEP) moderated the differences in performance on the stop signal task after sniffing water and sniffing alcohol was examined using a repeated measure analysis of variance. Trait temptation significantly moderated the difference between conditions, multivariate $F(1, 151) = 3.92$, $p < .05$ (Figure 2 shows this relationship with temptation to drink split at the median). Individuals who were higher in trait temptation (and thus drank more on average, had a higher SMAST score, and were more likely to binge) performed worse on the stop signal task after sniffing alcohol compared with individuals lower in trait temptation. The effect of temptation on performance after sniffing water was much weaker. This reinforces the results presented above: The stronger the temptation to drink, the less likely that the person could inhibit a response. No other between-persons factor moderated the relationship between sniffing alcohol and stop signal performance.

Handgrip

Individuals released the handgrip sooner after sniffing alcohol ($M = 44.0$ s, $SD = 36.9$) than after sniffing water ($M = 48.2$ s, $SD = 41.6$), $t(158) = 2.24$, $p < .025$. Controlling for order of task (e.g., sniff water first vs. sniff alcohol first) strengthened the magnitude of this effect, $F(1, 157) = 8.10$, $p < .005$. As would be expected, there was a main effect for gender, $F(1, 157) = 61.8$, $p < .001$. Controlling for gender in an analysis of covariance (to

Table 1
Multiple Regression Predictors of Stop Signal Performance After Sniffing Water and Alcohol

Predictor	*B*	*SE*	*t*	R^2
After alcohol exposure				
Step 1				.01
Mood	0.006	0.007	0.880	
Arousal	0.001	0.010	0.085	
Step 2				.04*
Urge	−0.009	0.004	1.91*	
After water exposure				
Step 1				.01
Mood	0.001	0.007	0.188	
Arousal	−0.018	0.012	1.52	
Step 2				.03
Urge	−0.004	0.004	0.898	

Note. $N = 160$. *df*s = 157 (Step 1) and 156 (Step 2).
* $p < .05$.

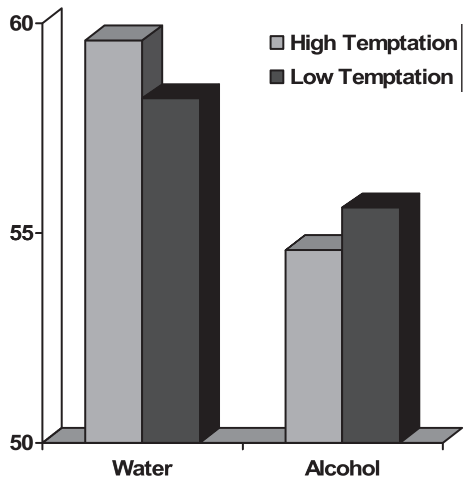

Figure 2. Correct responses on stop signal measure after sniffing water and alcohol for individuals high and low in trait temptation to drink alcohol (Temptation and Restraint Inventory–Cognitive and Emotional Preoccupation, split at median).

help equate male and female performance), however, had no effect on the outcome, $F(1, 156) = 3.78$, $p < .05$, and gender did not interact with trial, $F(1, 156) = 1.40$, *ns*.

Consistent with the stop signal analyses, the effects of sniffing alcohol and water on subsequent self-control performance do not appear to be moderated by mood or arousal. As shown in Table 2, urge to drink the alcohol predicted handgrip squeezing performance above and beyond the effects of mood and arousal, $\Delta R^2 = .025$, $F(1, 153) = 4.04$, $p < .05$. Urge to drink the water did not predict handgrip performance after sniffing the water, much like the stop signal analyses, $\Delta R^2 = .004$, $F(1, 153) = 0.56$, *ns*. Unlike the stop signal, trait temptation did not moderate handgrip performance after sniffing alcohol. No other individual difference moderated the effect.

Discussion

After sniffing alcohol, social drinkers performed more poorly on two different and otherwise unrelated tasks than after sniffing water. That is, after being exposed to the sight and smell of their typical alcoholic beverage but not drinking it, social drinkers were less able to stop themselves from responding when a tone sounded and were less able to overcome physical fatigue and discomfort to squeeze a handgrip. These effects were stronger for people who are more tempted to drink (measured at both the trait level and the state level). The results are in agreement with the arguments of the self-control strength model and are largely consistent with previous studies on that model.

Further analysis indicated that the negative relationship between resisting a temptation and subsequent self-control performance cannot be accounted for by mood or arousal. Indeed, controlling for mood and arousal had little effect on the relationship between how much the individual had to fight against the temptation and subsequent self-control performance. The within-person design (participants sniffed both water and alcohol) further reinforced the significance of fighting a temptation in undermining self-control performance. Finally, consistent with previous research (Muraven & Slessareva, 2003), fighting against a temptation had no effect on tasks that did not require self-control, as predicted by the self-control strength model.

Implications

The present findings may help explain how resisting temptations affects performance on a variety of tasks. Being exposed to a tempting substance, like when social drinkers have to look at, sniff, and imagine drinking their preferred alcoholic beverage without drinking it, likely triggers an automatic inclination to drink it (Tiffany, 1990). These cues may also trigger a competing intent not to drink it (Breiner, Stritzke, & Lang, 1999), leading to response conflict. Making the decision not to drink under such competing responses may require self-control (Heather, 1998), and this exertion of self-control may deplete self-control capacity.

In other words, fighting against a temptation, such as the urge to drink or smoke, may put individuals at risk for a subsequent loss of self-control. For example, drinkers who suppressed their urge to drink in a cue exposure paradigm subsequently smoked more than drinkers who monitored their urge to drink (Palfai, Colby, Monti, & Rohsenow, 1997). Similarly, smokers abstaining from smoking performed worse than their baseline on vigilance tasks (Parrott, Garnham, Wesnes, & Pincock, 1996) and worse than smokers who were not controlling their addiction (Hughes, Keenan, & Yellin, 1989). Similarly, research has found that smokers who had abstained from cigarettes for 24 hr ate more ice cream than participants who were not abstaining (Duffy & Hall, 1988; see also Spring, Wurtman, Gleason, Wurtman, & Kessler, 1990); these effects were greatest for participants who were high in restrained eating (i.e., dieters). If individuals were coping with smoking cessation by eating, dieters and nondieters would presumably eat the same amount. The increased eating that occurred only in dieters suggests that controlling the urge to smoke undermines self-control.

Table 2
Multiple Regression Predictors of Handgrip Squeezing Performance After Sniffing Water and Alcohol

Predictor	*B*	*SE*	*t*	R^2
After alcohol exposure				
Step 1				.01
Mood	0.422	0.380	1.11	
Arousal	0.003	0.528	0.005	
Step 2				.04*
Urge	−0.418	0.208	2.01*	
After water exposure				
Step 1				.01
Mood	−0.710	0.442	1.6	
Arousal	−0.719	0.671	1.07	
Step 2				.02
Urge	−0.238	0.234	1.02	

Note. $N = 160$. *df*s = 157 (Step 1) and 156 (Step 2).
* $p < .05$.

When the results of this study are paired with our previous research (Muraven et al., 2002, 2005), a dynamic picture of the regulation of alcohol intake emerges. Resisting the urge to drink depletes self-control strength, thereby undermining subsequent self-control performance. At the same time, individuals lower in self-control strength are less able to regulate their alcohol intake and are more likely to drink to excess and violate self-imposed drinking limits. This presents a troubling model of how fighting a temptation may get more difficult over time and eventually lead to a loss of control.

Practically, one way to avoid this cycle may be to reduce the number of alcohol cues in one's environment, in order to reduce the self-control demands. Limiting other self-control demands, to maximize the amount of self-control resources available to control alcohol intake, may also help in this regard. Finally, the self-control strength model suggests that the regular exercise of self-control may actually help improve self-control in the long run (Muraven, Baumeister, & Tice, 1999).

Caveats and Conclusions

Certain things need to be kept in mind when interpreting these results. First, the current sample consisted of social drinkers. Within that sample, there was considerable evidence that individuals who are more tempted perform more poorly on later tests of self-control. Care must be taken before generalizing these results to alcoholics or other addictive disorders, nonetheless.

Second, although the data were collected and analyzed within participants and there was no relationship between potential confounds (e.g., mood, arousal) and self-control performance, it is possible that some unmeasured variable is compromising the study's internal validity. There was a negative relationship between how hard participants fought against the urge to drink and self-control performance, as predicted by the self-control strength model. There also was no difference in performance on tasks that did not require self-control, although the task that did not require self-control may have been easier or less complex than the tasks that required self-control. Previous research has found that depleted individuals do perform equal to nondepleted individuals on moderately difficult tasks that do not require self-control (Muraven & Slessareva, 2003). Moreover, the same effect was found on two very different tasks (squeezing a handgrip and inhibiting a response) that share nothing in common except the need to exert self-control.

Perhaps most significantly, we did not directly assess self-control strength. Indeed, as the technology currently stands, there is no way to observe whether self-control strength has been depleted; any measurement must be done indirectly, by measuring performance on subsequent self-control tasks. As noted above, the results of the present study are consistent with that theory and inconsistent with other theories, thus leading us to conclude that resisting the temptation of drinking alcohol is depleting. The results point to the importance of reducing the number of temptations in the environment as well as the careful consideration of how dealing with temptations may affect subsequent performance.

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