Drinking without thinking: An implicit measure of alcohol motivation predicts failure to control alcohol use

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Addiction is characterized by dyscontrol – substance use despite intentions to restrain. Using a sample of at-risk drinkers, the present study examined whether an implicit measure of alcohol motivation (the Implicit Association Test [IAT]; Greenwald, A.G., McGhee, D.E., & Schwartz, J.L.K. (1998). Measuring individual differences in implicit cognition: the Implicit Association Test. Journal of Personality and Social Psychology, 74, 1464–1480) would predict dyscontrol of alcohol use. Participants completed an IAT and, to elicit motivation to restrain alcohol use, were instructed that greater consumption in a taste test would impair performance on a later task for which they could win a prize. All participants viewed aversive slides and then completed a thought-listing task. Participants either exerted self-control by suppressing negative affect and thoughts regarding the slides or did not exert self-control. Post-manipulation, the groups did not differ in mood, urge to drink or motivation to restrain consumption. During the subsequent taste test, participants whose self-control resources were depleted consumed more alcohol than did those in the control group. Additionally, the IAT, but not an explicit measure of alcohol motivation, more strongly predicted alcohol use when self-control resources were depleted. The results indicate that the IAT may have utility in predicting dyscontrolled alcohol use.

Introduction

... the evil which I would not do, that I do. – Romans 7:19 (21st Century King James Version)

Most of us who have struggled with the difficulties of changing behavior will understand the dispiriting insight described in the book of Romans. Life is replete with behavioral impulses to do things that run counter to our conscious intentions. Inability to override these impulses can lead to consequences that may be relatively minor or more life altering, such as relapse of addictive behavior. Understanding the processes that lead to substance use despite conscious intentions to refrain may lead to better prediction of use in high-risk situations. This research examined how the depletion of self-control resources can influence the ability to control alcohol use and how the use of an implicit measure of alcohol motivation can predict self-control failure.

Dual-process models of substance use

A defining element of addiction is dyscontrol – the difficulty in refraining from substance use when one has conscious intentions to do so (Widiger & Smith, 1994). This accounts for the high relapse rates found after treatment (McKay, Franklin, Patapis, & Lynch, 2006) and substance users’ self-reported difficulty in controlling their urges (Gudgeon, Connor, Young, & Saunders, 2005). Why is it so hard to refrain from using? Addiction researchers have increasingly used the cognitive psychology construct of automatic mental processes (Shiffrin & Schneider, 1977) to model the non-volitional nature of addiction (see Goldman et al., 1991; Tiffany, 1990; Wiers & Stacy, 2006a). Automatic processes are differentiated from controlled processes in that automatic processes are usually defined as being (a) unintentional, (b) efficient (i.e., effortless), (c) difficult to control, or (d) not involving awareness whereas controlled processes are defined as being (a) intentional, (b) relying upon limited attentional resources, (c) controllable, and (d) occurring within awareness (Bargh, 1994). A number of addiction theorists propose that substance use behavior may begin as a function of controlled processes and, with continued use, become more a function of automatic processes (Oei & Baldwin, 1994; Tiffany, 1990; Wiers & Stacy, 2006b). That is, substance use becomes less influenced by a deliberate “mental algebra” (Goldman et al., 1991) and more under the control of spontaneous, nonvolitional responses to substance use cues.
The automatization of appetitive responses to substance cues means that they become the default response. That is, the mere presence of a substance cue may automatically (i.e., unintentionally, without the need for deliberate introspection) activate positive attitudes (Fazio, Sanbonmatsu, Powell, & Kardes, 1986) and approach behavioral tendencies (Chen & Bargh, 1999). However, controlled processes may still influence behavior. For example, one dual-process model proposes that attitudes can influence behavior through relatively spontaneous or deliberative processes and that motivation and opportunity to exert control are determinants of whether the attitude–behavior relation is spontaneous (i.e., an automatic affective reaction) or deliberative (i.e., an effortful cost–benefit analysis) (Fazio, 1990). Thus, a decision to drink may be mediated by conscious deliberation if one is motivated to maintain a low blood alcohol level in order to drive home and has the cognitive resources (e.g., energy, time to think) to do so. However, in many cases either the motivation to deliberate (e.g., when one’s goal for the night is to unwind) or the opportunity to do so (e.g., because of fatigue or other attentional demands) may be lacking, in which case drinking may be more likely to be mediated by automatic (i.e., unintentional) affective responses to internal or external alcohol cues.

Recent research supports dual-process models of the relation between affect and behavior in that implicit and explicit measures predict different categories of behavior. For example, explicit measures of race attitudes predict behaviors that are more easily controlled (e.g., deliberation of the fairness of a race-related trial) whereas implicit measures of race attitudes predict behaviors that are less easily controlled (e.g., nonverbal behavior with someone of a different race) (Dovidio, Kawakami, & Gaertner, 2002; Fazio, Jackson, Dunton, & Williams, 1995). Similar results have been found for the relation between attitudes and other behaviors (Perugini, 2005) and in the domain of self-concept (Asendorpf, Banse, & Mücke, 2000). Asendorf et al. (2000) found that an explicit measure of shyness predicted shyness behaviors categorized as more easily controlled (e.g., speech) whereas an implicit measure of shyness predicted shyness behaviors categorized as difficult to control (e.g., body tenseness). These findings support the idea that if either motivation to control behavior or opportunity to do so is lacking, automatic processes will more strongly influence the behavioral outcome.

An applied instance of dual-process models occurs when a conflict exists between automatic appetitive responses and effortful inhibition to control the appetitive response – between temptation and restraint. Thus, when offered a beer, an at-risk drinker who is attempting to abstain may try to inhibit an automatic disposition to consume. Theoretically accounts of self-regulation propose that the success of self-regulation attempts is influenced by the limited nature of self-control resources (Baumeister, Bratslavsky, Muraven, & Tice, 1998). That is, expending self-control resources on one task reduces their availability for subsequent tasks. A number of studies have demonstrated that self-control exertion (e.g., suppressing emotion or forbidden thoughts) impedes subsequent ability to self-regulate (e.g., persistence on a difficult puzzle, further control of emotion) (Baumeister et al., 1998).

Recent research has begun to examine whether limited self-control resources may also influence the ability to restrain alcohol use. In one study, male social drinkers were given a reason to restrain their alcohol consumption in a taste test and half of the participants’ self-control resources were depleted by suppressing thoughts about a white bear (Muraven, Collins, & Neinhaus, 2002). The results indicated that the depletion group consumed more alcohol than did the control group. In a complementary study, the daily experience of self-control demands predicted the likelihood of violating self-generated drinking limits in a sample of underage social drinkers (Muraven, Collins, Shiffman, & Paty, 2005).

Assessing automatic substance use motivation

The above analysis suggests that measures of automatic substance use motivation may have utility in predicting failure to control substance use behavior. Addiction researchers have begun using implicit measures to evaluate the role of automatic substance use–affect associations in substance use behavior. This research has included priming tasks (Ostafin, Palfai, & Wechsler, 2003; Zack, Poulos, Frapopoulos, & MacLeod, 2003), word association tasks (Stacy, 1997) and stimulus compatibility tasks (De Houwer & De Bruycker, 2007). Of the variety of measures used to assess automatic stimulus–affect associations (see Fazio & Olson, 2003), the one that has become most widely used is the Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998).

The IAT is assessed by having participants categorize stimuli from four categories – two target categories (the category of interest such as alcohol and a comparison category such as water) and two attribute categories (such as positive and negative) – by pressing one of two response keys. During the combination blocks, each response key is paired with one target and one attribute category. The IAT is based on the idea that stronger stimulus–affect associations will result in faster response times when one key is paired with affectively congruent categories (e.g., for someone who uniformly likes drinking, alcohol and positive) than when the key is paired with affectively incongruent categories (e.g., alcohol and negative). The IAT has good psychometric properties (see Greenwald & Nosek, 2001) and has been increasingly used in experimental psychopathology research (De Houwer, 2002; Teachman, Gregg, & Woody, 2001).

Early use of the IAT (and other implicit measures of stimulus–affect associations) examined the strength of the relation between the stimulus of interest and valence (i.e., positive–negative) (Fazio et al., 1986; Greenwald et al., 1998). Clinical researchers have begun to modify the affective attribute categories of the IAT in order examine processes that are specific to particular disorders (e.g., danger–safety for phobic samples [Teachman et al., 2001]). Two variations of alcohol–affect associations have been developed. The first variation of alcohol–affect associations used arousal (active–passive) attribute categories (Wiers, van Woerden, Smulders, & de Jong, 2002) as arousal is an important dimension in both affect (Russell, 1980) and alcohol expectancies (Goldman, Del Boca, & Darkes, 1999). Wiers et al. (2002) found that alcohol behavior was predicted by both alcohol–valence and alcohol–arousal IATs.

The second variation of alcohol–affect associations used action disposition (approach–avoid) attribute categories (Palfai & Ostafin, 2003), as action dispositions are a fundamental dimension of affect (Davidson, 1993; Lang, 1995) and serve as a common final pathway to substance use across a variety of motivational models (Baker, Morse, & Sherman, 1987; Robinson & Berridge, 1993; Stewart, de Wit & Eikelboom, 1984). The results of this study indicated that automatic alcohol–approach associations predict heavy drinking episodes, alcohol cue reactivity (i.e., urge to drink), and difficulty in controlling alcohol use (Palfai & Ostafin, 2003). A second study replicated the relation between automatic alcohol–approach associations with heavy drinking episodes and cue reactivity and found that the approach IAT predicted variance of alcohol use beyond that accounted for by an explicit measure of alcohol motivation (Ostafin & Palfai, 2006).

Although this work indicates that automatic processes are involved in alcohol behavior, no research has been conducted on their role in the failure to self-control alcohol use when there are simultaneous motives to consume and to restrain consumption. Additionally, research on the role of self-control resources in disinhibited drinking (e.g., Muraven et al., 2002) would be complemented by examining how automatic processes influence alcohol use when self-control resources are depleted.
Study overview

The current study was designed to examine the contribution of self-control resources and automatic alcohol motivation in the self-regulation of alcohol use. To do this, participants completed a measure of automatic alcohol motivation (the IAT) after which half of the participants completed tasks designed to deplete their self-control resources. Ability to self-regulate alcohol use was assessed in an ad lib drinking task for which participants were given a reason to restrain their consumption. We predicted that when the resources needed to control automatic alcohol motivation were depleted, participants would have more difficulty controlling alcohol use and that alcohol use would be more strongly influenced by automatic alcohol motivation. Specifically, we had two primary hypotheses. First, we predicted that participants whose self-control resources were depleted would consume more alcohol than would the control participants. Second, we predicted that that the IAT (but not an explicit measure of alcohol motivation) would more strongly predict alcohol use when self-control resources were depleted.

Method

Participants

Eighty-seven participants were recruited from advertisements that requested regular alcohol drinkers. Inclusion criteria included: (a) at-risk drinking behavior (≥ 15 drinks/week and ≥ 5 drinks/occasion at least once per week for males and ≥ 8 drinks/week and ≥ 4 drinks/occasion at least once per week for females) as defined by NIAAA (US Department of Health and Human Services, National Institute on Alcohol Abuse and Alcoholism, 1995); (b) regular beer consumption (at least 25% of alcohol consumed); (c) age between 21 and 40 years old; and (d) English as a first language. Two participants were dropped because English was not their first language. Extremely heavy drinkers (more than 40 drinks per week) were excluded from the study, as were females known to be pregnant and those reporting a history of problem drinking or medical conditions and medications that would contraindicate alcohol consumption. Heavy drinkers and those reporting a history of problem drinking were offered a list of counseling resources for managing drinking. The final sample reported a mean age of 27.04 years (SD = 5.71). Participants reported drinking a mean of 4.69 (SD = 1.59) days per week and 5.17 (SD = 2.09) drinks per occasion the previous month. The sample was primarily male (n = 61) and self-reported ethnicity was White (n = 64), Hispanic (n = 8), Multi-racial (n = 6), Asian/Pacific Islander (n = 4), Black (n = 2), and American Indian/Alaskan native (n = 1). The majority of participants reported that they had not obtained an undergraduate degree and were not pursuing one (n = 43), with the rest reporting having obtained an undergraduate degree (n = 21), currently in an undergraduate program (n = 16), having obtained a graduate degree (n = 3) and currently in a graduate program (n = 2). Participants received $50 for their time and effort.

Measures

Typical drinking behavior

A calendar-based measure was used to assess patterns of drinking, including frequency of use and quantity consumed per occasion. Calendar measures of alcohol use have demonstrated good reliability and validity (Sobell, Maisto, Sobell, & Cooper, 1979; Sobell & Sobell, 1992).

Automatic alcohol motivation

Each participant completed an IAT to assess automatic alcohol-motivation associations. The IAT was presented on a personal computer with Inquisit software (Draine, 2004). The IAT consisted of having participants categorize stimuli from four categories – two target categories (e.g., pictures of beer and water) and two attribute categories (e.g., approach and avoidance-related words). The IAT stimuli consisted of five pictures of beer in glasses and pitchers, five pictures of water in glasses and pitchers, five approach-related words (advance, approach, closer, forward, toward), and five avoidance-related words (avoid, away, escape, leave, withdraw). The IAT was presented in seven blocks: (a) a 14-trial target discrimination block (e.g., left = beer and right = water); (b) a 14-trial attribute discrimination block (left = approach and right = avoid); (c) a 20-trial combination block (left = beer + approach and right = water – avoid); (d) a 40-trial combination block of the same combination in (c); (e) a 14-trial target discrimination block in which the target categories were reversed (left = water and right = beer); (f) a 20-trial reversed combination block (left = water + approach and right = beer – avoid); and (g) a 40-trial combination block of the same combination in (f). If participants made an error, they saw an error message and were required to make the correct response before the next trial was presented. Two IAT orders were utilized: one with the beer and approach combination first and one with the water and approach combination first. These two IAT orders were counterbalanced across participants. The IAT score was calculated as a difference score between the mean response times of the beer-approach/water-avoid block and the water-approach/beer-avoid block, with larger scores indicating stronger automatic approach motivation toward alcohol. The IAT score was calculated according to the D-measure algorithm suggested by Greenwald, Nosek, and Banaji (2003).

Urge rating

Urge to drink at baseline and after the beers were presented was assessed with an 11-point Likert item ranging from 1 (no urge at all to drink alcohol) to 11 (very strong urge to drink alcohol). This measure has demonstrated good psychometric properties (Rohsenow et al., 1997).

Explicit alcohol motivation

Explicit alcohol motivation was assessed with the two urge ratings and two 11-point Likert items. One item assessed approach responses (“Overall, alcohol makes me want to...”) on a scale ranging from –5 (Strongly avoid it) to 5 (Strongly approach it) and the other item assessed wanting responses (“Overall, regarding alcohol...”) on a scale ranging from –5 (I strongly don’t want it) to 5 (I strongly want it). The four items were aggregated into a single variable (Coefficient alpha = 0.76).

Taste test

A modified taste-test procedure (Marlatt, Demming, & Reid, 1973) was used to measure alcohol consumption. Participants were instructed to make taste ratings on three different brands of beer (a glass of the beer that participants endorsed as being their favorite brand during the phone screen, a glass of Budweiser beer, and a glass of O’Douls’s Amber non-alcoholic beer). Each glass contained 350 mL of beer. Participants were not told the identity of the brands they were drinking. Participants were instructed to rate each of the three beers on a number of adjectives (e.g., “crisp”, “bitter”). Each adjective was presented on the computer screen three times, once for each beer. Participants were required to make a rating on a scale ranging from 1 (strongly disagree) to 4 (strongly agree) before proceeding to the next adjective. Participants were instructed to take their time and drink as much as they needed to make each rating. Participants were given 10 min to sample the beers and make their ratings, although they were not informed of this duration beforehand.
**Hedonic response to alcohol**

The first two adjectives of the taste test were “delicious” and “satisfying”. Each of the three beers was rated on these adjectives. The resultant six items were aggregated into a mean hedonic response variable (Coefficient alpha = 0.56).

**Affect state**

Current affect was measured with the Self Assessment Manikin (SAM; Bradley & Lang, 1994) valence scale. This scale is a nonverbal assessment of affect consisting of seven pictures of a block figure whose facial features represents feeling states ranging from Happy (=1) to Unhappy (=7). Participants were instructed to place a mark on the picture that best represents their feeling at the current time. The SAM has demonstrated good validity with other self-report measures of affect (Bradley & Lang, 1994).

**Manipulation check**

Participants used a 25-point Likert scale to answer a number of questions about their experience of the study manipulations (e.g., effort exerted in suppressing negative affect or cognitions related to the aversive pictures that were presented).

**Procedure**

Participants were screened by phone to determine eligibility for the study. If callers were eligible, the screener asked for the brand of beer that the caller liked and drank most frequently (to be used in the taste test). Additionally, eligible callers were instructed to not consume alcohol the day of the study, to arrange a ride to and from the study and to not eat for 3 h prior to the study. Participants were run individually in laboratory space constructed to resemble a real bar. On arrival, participants completed the consent form, presented proof of age and had their BAC assessed. All participants met the criterion of a zero BAC. All female participants completed a pregnancy test with negative results.

The experimenter told participants that the purpose of the study was to examine how people perceive alcohol use and intoxication. They were also told that they would begin the study with a reaction time task on the computer, that they would be asked to consume and make ratings of several beers in a taste test, and that they would have another reaction time task after the taste test. In order to create motivation to restrain drinking, the experimenter told participants: (a) that if they performed fast enough on the second reaction time task, they could win a prize contingent on their performance on the second reaction time task after the taste test, and that if their reaction time was fast enough, they could win a prize. Participants were told that the purpose of the study was to examine how people perceive alcohol use and intoxication.

**Baseline measures**

After reading and signing an IRB-approved consent form, participants completed baseline assessments of urge to drink and the SAM. After this, the experimenter administered the IAT. After completing the IAT, participants completed a measure assessing demographics, drinking behavior over the past month and items assessing explicit alcohol motivation. The taste test procedure was then reviewed so that participants were familiar with the computer format of the task.

**Data analysis**

The hypothesis that depletion of self-control resources would lead to greater alcohol consumption was examined with an analysis of variance (ANOVA). The hypothesis that automatic alcohol motivation would more strongly predict alcohol use when self-control resources were depleted was examined with a regression analysis using the
steps proposed by Baron and Kenny (1986) to establish a moderator–interaction effect. A series of t-tests were conducted to determine that the manipulation was successful and that the two groups did not differ on non-experimental variables that could influence drinking behavior. Pearson’s r was used to examine the relation between the alcohol motivation variables and alcohol consumption.

Results

Preliminary analyses

Group randomization
A number of t-tests were conducted in order to examine whether the experimental and control groups were equivalent on individual difference variables that could potentially influence consumption in the taste test. The results indicated that there were no differences between groups on current age, age of becoming a regular drinker, gender composition, drinking days per week, and average amount consumed per drinking day (all ps > 0.40).

Depletion task manipulation check
Manipulation checks were conducted for both the unpleasant image viewing task and thought-listing task designed to deplete self-control resources. Results indicated that the manipulation led to medium-to-large effect size differences, with the depletion group reporting: (a) a trend toward exerting more effort to suppress negative emotion related to the images and experiencing significantly less negative emotion after the image viewing task and (b) exerting significantly more effort to suppress thoughts about the images and experiencing significantly fewer image-related thoughts in the thought-listing task than did the control group (see Table 1).

Alcohol variables
Across both groups, participants consumed a mean of 442.16 mL (SD = 183.69) of alcohol with a range between 100 mL and 875 mL. Participants’ mean BAC was 0.03 (SD = 0.03). The urge measure demonstrated a non-normal distribution and was consequently log-transformed. A repeated measures analysis using urge rating as the within-subjects indicated that urge to drink increased from baseline to the presentation of the beers, F (1, 84) = 28.42, p = 8.08 × 10^−7. The mean untransformed urge to drink was 3.96 (SD = 2.41) at baseline and 5.81 (SD = 2.90) at the presentation of beers. The mean hedonic response across the three beers was 2.55 (SD = 0.56) with a range between 1.17 and 3.67. Correlations among the alcohol motivation and consumption variables are presented in Table 2.

Primary analyses

Effect of self-control resource depletion on alcohol use
The first main hypothesis was that at-risk drinkers whose self-control resources were depleted would consume more alcohol than those whose resources were not depleted. The results indicated that depletion condition participants consumed more alcohol (M = 478.84 mL, SE = 26.92) in the 10 min taste test than did those in the control condition (M = 400.90 mL, SE = 28.55), F (1, 83) = 3.95, p = 0.05. This difference represents a medium effect size (Cohen’s d = 0.44). This result was maintained when controlling for typical drinking behavior (drinks per occasion) in an ANCOVA, F (2, 82) = 4.11, p = 0.05.

We conducted a number of t-tests to examine whether the two groups were equivalent on study specific variables that could potentially influence consumption in the taste test. The results indicated that there were no differences between groups on affect state (measured with the SAM) preceding the taste test, t (83) = 0.36, p = 0.72 and hedonic response to alcohol (i.e., “delicious” and “satisfying” ratings for each beer), t (83) = −1.43, p = 0.16. Results further indicated that there were no differences between groups on baseline urge to drink, t (83) = −0.67, p = 0.51, cue exposure urge to drink, t (83) = −1.02, p = 0.31, extent to which the opportunity to win a prize motivated restrained consumption, t (83) = 1.23, p = 0.22, and understanding that limiting drinking would help reaction time performance to win a prize, t (83) = −0.75, p = 0.46. These sets of analyses suggest that the group difference in alcohol consumption was a function of depleted self-control resources rather than alternative variables such as mood, hedonic response to the alcohol, urge to drink or motivation to restrain use.

Predictive validity of the IAT when self-control is depleted
The second main hypothesis was that the IAT would more strongly predict alcohol consumption when self-control resources were depleted. This moderator–interaction effect was examined with a regression analysis of alcohol consumption on the IAT score and Condition variables entered as Step 1 and a product of the standardized values of the IAT score and Condition variables entered as Step 2. The results indicated that the Condition variable moderated the relation between the IAT and alcohol consumption (β = 0.25, p = 0.03) (see Table 3). Further, the interaction effect remained when controlling for the explicit measure of alcohol motivation and typical drinking behavior (drinks per occasion) (β = 0.22, p = 0.05). In order to assist in the interpretation of the interaction effect, we performed zero-order correlation analyses between the IAT and alcohol consumption for both conditions. The results indicate that when at-risk drinkers are motivated to both consume and restrain consumption, the IAT predicts alcohol consumption when self-control resources are depleted (r [45] = 0.36, p = 0.01), but not when self-control resources are available (r [40] = −0.01, p = 0.94). This interaction is represented in Fig. 2.

Confidence in the moderator result would be strengthened by demonstrating that the self-control condition did not also moderate the relation between the IAT and typical drinking

### Table 1
Manipulation checks for the self-control depletion tasks

<table>
<thead>
<tr>
<th>Variable</th>
<th>Depletion group (n = 45)</th>
<th>Control group (n = 40)</th>
<th>t-value</th>
<th>p-value</th>
<th>Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viewing unpleasant images task</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suppress affect</td>
<td>12.44 (7.86)</td>
<td>9.45 (7.39)</td>
<td>−1.80</td>
<td>0.07</td>
<td>0.40</td>
</tr>
<tr>
<td>Negative affect</td>
<td>3.40 (1.01)</td>
<td>4.01 (1.45)</td>
<td>2.42</td>
<td>0.02</td>
<td>0.53</td>
</tr>
<tr>
<td>Thought-listing task</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suppress thoughts</td>
<td>11.53 (8.17)</td>
<td>7.48 (7.53)</td>
<td>−2.37</td>
<td>0.02</td>
<td>0.52</td>
</tr>
<tr>
<td>Image-related thoughts</td>
<td>6.60 (6.25)</td>
<td>11.63 (8.28)</td>
<td>3.18</td>
<td>0.002</td>
<td>0.70</td>
</tr>
</tbody>
</table>

Suppress affect – effort exerted to suppress negative emotion during the unpleasant images viewing task on a 25-point Likert scale; Negative affect – affect immediately after the unpleasant images viewing task measured by the SAM on a seven-point scale; suppress thoughts – effort exerted during the thought-listing task to suppress thoughts about the unpleasant images on a 25-point Likert scale; image-related thoughts – amount of unpleasant image-related thoughts experienced during the thought-listing task on a 25-point Likert scale.
behavior. If the condition did moderate the relation between the IAT and typical drinking, it would suggest that the positive relation between the IAT and alcohol consumption (in the taste test) for the depletion group was a function of an unknown variable, and not the experimental manipulation. This moderator–interaction effect was examined with a regression analysis of typical amount of alcohol consumed per occasion over the previous month on the IAT score and Condition variables entered as Step 1 and a product of the standardized values of the IAT score and Condition variables entered as Step 2. The results indicated that the Condition variable did not moderate the relation between the IAT and typical alcohol consumption ($\beta = -0.04$, $p = 0.74$). This finding supports the interpretation that it is the depletion of self-control resources that sets the stage for an increased role of automatic alcohol motivation in dyscontrolled alcohol use.

We examined whether the explicit measure of alcohol motivation would similarly predict alcohol consumption more strongly when self-control resources were depleted. The results of a regression analysis of alcohol consumption on the explicit measure and Condition variables entered as Step 1 and a product of the standardized values of these variables entered as Step 2 indicated that the Condition variable did not moderate the relation between explicit alcohol motivation and alcohol consumption ($\beta = 0.09$, $p = 0.40$). In conjunction with previous analyses, this result suggests that alcohol dyscontrol may be more influenced by implicit alcohol motivation than explicit alcohol motivation.

**Secondary analyses**

**IAT validity**

Several analyses were conducted to examine the validity of the IAT as a measure of automatic alcohol motivation. First, zero-order correlations with the entire sample indicated that the IAT predicted alcohol consumption in the taste test ($r [85] = 0.22$, $p = 0.04$) and a trend toward correlation with typical amount consumed per occasion ($r [85] = 0.19$, $p = 0.09$), though not typical frequency of use ($r [85] = -0.01$, $p = 0.92$). These analyses support previous findings of a relation between automatic alcohol motivation and quantity but not frequency of alcohol use (Ostafin & Palfai, 2006; Palfai & Ostafin, 2003). The relation between the IAT and alcohol consumption in the taste test remained significant when controlling for typical drinking (drinks per occasion) ($pr [82] = 0.24$, $p = 0.03$) and the explicit measure of alcohol motivation ($pr [82] = 0.23$, $p = 0.04$). These results suggest two things. First, they indicate a meaningful distinction between implicit and explicit measures of alcohol motivation. Second, they indicate that the prediction of alcohol consumption by the IAT was a function of the role of automatic alcohol–approach associations in alcohol use and not simply that the IAT served as a proxy for typical drinking behavior.

**Discussion**

This research examined the contribution of self-control resources and automatic appetitive processes in the ability to restrain alcohol consumption. The results indicate that when at-risk drinkers experience a conflict between desire to consume and to restrain consumption, they are likely to drink more when their self-control resources are depleted, replicating Muraven et al. (2002). Further, the results indicate that when self-control resources are depleted, an implicit (but not explicit) measure of alcohol motivation is more strongly related to consumption despite intentions to restrain. In sum, these results suggest that dyscontrolled alcohol use is a function of self-control resources and of spontaneous motivational responses to alcohol.

A number of supplementary analyses were conducted to examine alternative explanations for the main findings. The results of these analyses suggest that the group difference in alcohol consumption was a function of depleted self-control resources and not of group differences in craving for the alcohol, liking the alcohol, motivation to restrain consumption, or typical drinking behavior. The most plausible alternative explanation for the results is based on work demonstrating that suppression of a thought (e.g., a white bear) leads to an increase of that thought once efforts to suppress it are relaxed (Wegner, Schneider, Carter, & White, 1987). Similar rebound effects have been found for emotion suppression (Levitt, Brown, Orsillo, & Barlow, 2004). This suggests that suppression of negative mood in the first depletion task could have led to a rebound of negative affect, prompting greater alcohol consumption in the depletion condition. This explanation is contradicted by the finding that the depletion group did not demonstrate a rebound in negative affect, but was instead equal to the control group immediately before the taste test. This result is consistent with other research indicating that emotion suppression may not lead to a rebound effect (Roemer & Borkovec, 1994) but may still deplete self-control resources (Baumeister et al., 1998). In sum, these additional analyses add confidence to the main findings of the role of self-control resources and automatic alcohol motivation in dyscontrolled alcohol use.

The current study expands upon past research using implicit measures to assess alcohol–affect associations. To our knowledge, this is the first study to use an objective measure of alcohol consumption rather than self-report (e.g., McCarthy & Thomp森, 2006; Palfai & Ostafin, 2003; Thush & Wiers, 2007; Wiers et al., 2002). In addition, although other research has examined the ability of automatic alcohol–affect associations to prospectively predict drinking behavior (Thush & Wiers, 2007; Wiers et al., 2002), this is the first study to demonstrate that automatic alcohol–affect associations predict future alcohol use while controlling for past alcohol use. This result indicates that automatic alcohol–affect associations influence alcohol use (rather than simply represent a proxy of typical drinking).

**Table 2**

Correlations among the motivation, affect and alcohol consumption variables ($N = 85$)

<table>
<thead>
<tr>
<th>Measure</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Implicit alcohol motivation</td>
<td>–</td>
<td>0.23</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>2. Explicit alcohol motivation</td>
<td>0.01</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>3. Baseline affect</td>
<td>–0.09</td>
<td>0.01</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>4. Pre-taste test affect</td>
<td>–0.01</td>
<td>0.02</td>
<td>0.31*</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>5. Alcohol consumed</td>
<td>0.22*</td>
<td>0.30*</td>
<td>0.16</td>
<td>–0.04</td>
<td>–</td>
</tr>
</tbody>
</table>

Implicit alcohol motivation – IAT score (larger scores = stronger appetitive motivation); Explicit alcohol motivation – self-report items (larger scores = stronger appetitive motivation); Baseline and Pre-taste test affect (larger scores = greater negative affect).

*p < 0.05.

**Table 3**

Self-control resource depletion as a moderator of the relation between automatic alcohol motivation and alcohol consumption ($N = 85$)

<table>
<thead>
<tr>
<th>Alcohol consumption</th>
<th>$R^2$</th>
<th>F-change</th>
<th>$\beta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IAT score</td>
<td>0.07</td>
<td>F (2, 82)–3.09</td>
<td>0.17</td>
</tr>
<tr>
<td>Condition</td>
<td></td>
<td></td>
<td>0.06</td>
</tr>
<tr>
<td>Step 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IAT score x condition</td>
<td>0.12</td>
<td>F (1, 81)–4.84</td>
<td>0.25*</td>
</tr>
</tbody>
</table>

IAT score (larger scores = stronger alcohol–approach associations); Condition – group assignment (Control = 1; Depletion = 2); IAT x Condition – product of the IAT and condition variables.

*p < 0.05.
The concept of dyscontrol – use despite intentions to restrain – is central to substance use disorders (Widiger & Smith, 1994). Recent theoretical and empirical work has examined the psychological factors that play a role in dyscontrolled alcohol use. This work has been conducted from the perspectives of self-regulation and implicit cognition. Self-regulation theory suggests that using self-control resources on one task limits their availability for later self-control tasks (Baumeister et al., 1998). Recent research has found that self-control exertion makes subsequent control of alcohol consumption more difficult (Muraven et al., 2002). Implicit cognition theory suggests that stronger automatic processes are more likely to influence behavior and, further, that they are more likely to do so if either motivation or opportunity for self-control are lacking (Fazio, 1990). Past research has found a relation between automatic processes and alcohol use (Ostafin & Palfai, 2006; Wiers et al., 2002) and between automatic alcohol motivation and self-reported difficulty in controlling alcohol use (Palfai & Ostafin, 2003). To our knowledge, the current study represents the first attempt to integrate the self-regulation and implicit cognition perspectives on alcohol use dyscontrol, yielding a comprehensive analysis of “both the ability to resist and the power of the temptation” (Herman & Polivy, 2004: 505). The study achieved this by assessing the relation between automatic alcohol motivation and dyscontrolled use when self-control resources were depleted.

The findings of this study make several other contributions. First, the results provide information regarding the contexts in which dyscontrol of alcohol use is more likely to occur. Early research on this topic consisted of compiling a list of high-risk situations from the self-report of abstaining users who had relapsed (Marlatt, 1996). The current study complements this work by experimentally examining a particular condition (i.e., self-control depletion) involved in dyscontrol and by indicating why alcohol dyscontrol may be more likely in high-risk situations (i.e., automatic alcohol motivation). Future research may benefit by examining whether automatic alcohol motivation also influences dyscontrolled alcohol use in other high-risk situations. For example, Marlatt’s (1996) taxonomy of high-risk situations includes a number of categories marked by the presence of negative affect. Although negative affect may increase the likelihood of alcohol use by enhancing the incentive salience of alcohol (Cox & Klinger, 1988), negative affect also consumes attentional resources (Kliegel & Jaeger, 2006; Meinhardt & Pekrun, 2003). This suggests that the ability to control automatic alcohol motivation may be compromised in negative emotional states.

This study also contributes to implicit cognition research. A number of dual-process models suggest that behavior can be influenced by both controlled and automatic mental processes (Chaiken & Trope, 1999). In particular, Fazio (1990) has proposed that automatically activated attitudes will influence behavior unless one is both motivated and has the opportunity to deliberately control the behavior. Initial research indicates that automatic attitudes are more likely to influence behavior that is difficult to control (e.g., nonverbal behavior; Fazio et al., 1995; Perugini, 2005). This research has relied upon a priori evaluation to categorize behavior as being difficult to control, though a recent study experimentally manipulated self-control resources (Hofmann, Rauch, & Gawronski, 2007). Hofmann et al. found that automatic attitudes toward candy predicted candy consumption more strongly when self-control resources were depleted than when they were not. However, depletion and control participants consumed the same amount of candy, weakening the ability to infer that the self-control manipulation made candy consumption more difficult to control. The current study contributes to this area through (a) its successful manipulation of the opportunity to control a behavior, indicated by the greater alcohol consumption in the depletion group, and (b) demonstrating that an implicit, but not explicit, measure of stimulus–affect associations predicts behavior when opportunity to control is lacking.

The findings from the current study have a number of clinical implications. First, as previously mentioned, the results suggest that depleted self-control resources may constitute a high-risk situation for dyscontrolled alcohol use. Consequently, relapse prevention may benefit from planning for situations in which self-control resources are likely to be depleted. This could be done through traditional strategies such as avoiding alcohol cues (Marlatt & Gordon, 1985) or through newer approaches such as strengthening self-control resources (Muraven, Baumeister, & Tice, 1999). Additionally, large outlays of self-control effort can be avoided by taking care of problems when they are still manageable and working toward a balanced life (Daley & Marlatt, 2006).

Second, implicit measures of alcohol motivation may be useful in predicting relapse in those who are attempting to abstain. Initial research indicates that automatic attentional biases to smoking and alcohol cues may predict treatment outcome (Cox, Hogan, & Kristian, 2002; Waters et al., 2003) and the current results suggest that automatic motivational responses may likewise predict treatment outcome. Thus, post-intervention performance on implicit measures may suggest a need for supplementary treatment.
Third, as evidence accumulates for the role of automatic processes in substance use (Wiers & Stacy, 2006a, 2006b), implicit measures may serve as a criterion in treatment development. For example, there is evidence that although traditional cognitive-behavioral strategies may change explicit alcohol–affect associations, they may have limited utility in changing implicit alcohol–affect associations (Wiers, Van de Luitgaarden, Van den Wildenberg, & Smulders, 2005). Treatment development may benefit from the incorporation of cognitive science theory. For example, Gawronski and Bodenhausen (2006; also see Wiers, de Jong, Havermans, & Jelicic, 2004) propose that whereas propositional reasoning (e.g., analysis of persuasive arguments) can change explicit attitudes, implicit attitudes are best changed through nonverbal processes such as altering the associative network through evaluative conditioning experiences (i.e., pairing the attitude object with positive or negative stimuli). There is a growing body of evidence that implicit attitudes can be changed (Gawronski & Bodenhausen, 2006), including those regarding social-cognition areas such as the self (Dijksterhuis, 2004) and age biases (Karpinski & Hilton, 2001) and clinical areas such as phobias (Teachman & Woody, 2003) and pain (Grimm, Erbe, von Collani, & Nestler, 2008). However, it appears that there is little research indicating that changes in performance on implicit attitude measures mediates changes in behavior. The field would greatly benefit from this sort of work. Treatment development may also benefit from novel approaches that emphasize changing the relation to one’s internal experience rather than changing the content of the experience (i.e., associative networks; Hayes, 2004). Recent research from our laboratory suggests that mindfulness (i.e., developing an awareness of and accepting attitude toward one’s internal experience; Bishop et al., 2004; Kabat-Zinn, 2003) may have utility in modulating the effect of automatic appetitive responses on behavior. Evidence from Ostafin and Marlatt (2008) indicates that mindfulness may decouple the relation between automatic alcohol motivation and hazardous drinking, which could partially account for the beneficial aspects of mindfulness training on substance use (Bowen et al., 2006).

The study had several limitations. One limitation is the means by which motivation to restrain alcohol use was encouraged. Participants were told that by restraining their alcohol use, they would be more likely to perform well enough on a later task to win an undisclosed prize. The results indicate that the unknown prize elicited modest levels of restraint motivation. The unknown nature of the prize may limit the generalizability of the results, as real life motivations to restrain are likely to be explicit (e.g., to avoid negative alcohol-related consequences) and personally meaningful. Future research would benefit by examining the moderating role of self-control depletion on the relation between automatic alcohol motivation and alcohol consumption in participants who are intrinsically motivated to restrain or abstain (e.g., Muraven et al., 2005).

A second limitation is that the use of an at-risk drinking sample limits the ability to generalize the findings to more severely disordered drinkers. Although we excluded alcohol dependent individuals because of the risks inherent in providing alcohol to this population (Wood & Sher, 2000), recent work suggests that severely disordered drinkers can be safely included in alcohol administration research as long as proper precautions are taken (Pratt & Davidson, 2005). Given the centrality of dyscontrol in dependence (Widiger & Smith, 1994) and the relation between the IAT and difficulty in controlling alcohol consumption (Palfai & Ostafin, 2003), we would expect that the results of this study would replicate in a sample of alcohol dependent drinkers. We believe that future research would thus benefit by examining the concurrent role of self-control and automatic appetitive processes in the dyscontrolled alcohol use of dependent drinkers. The taste test task may also limit the generalizability of the results. Although one study found that the taste test is related to typical drinking, the results also indicated that the task alters natural drinking behavior (George, Phillips, & Skinner, 1988). Consequently, external validity may benefit from using alternative self-administration methods such as those which incorporate monetary costs (O’Malley, Krishnan-Sarin, Farren, Sinha, & Kreek, 2002).

Another set of potential limitations regards the nature of the IAT. Although the IAT has a number of strengths including evidence for its reliability and validity (see Nosek, Greenwald, & Banaji, 2007), it has several limitations. One is that the IAT score is a difference score that incorporates both approach and avoidance associations, masking the respective contribution of each attribute. Several new measures have been developed to examine single associations (De Houwer, 2003; Karpinski & Steinman, 2006; Nosek & Banaji, 2001). However, it may be that a difference score is useful in predicting alcohol use because of the need for either the approach or avoidance motivational system to outweigh the other for behavioral output to occur (Miller, 1944). Another potential limitation specific to the IAT used in this study regards the use of beer for the category label and stimulus items. We used this IAT because it has demonstrated good reliability and validity (Ostafin & Palfai, 2006) and because participants would be consuming beer in this study. Although it is possible that a beer label and set of stimuli may not be relevant to individuals for whom beer is not the preferred alcoholic beverage, the significant reliability and validity findings of previous research with this IAT occurred despite the absence of an attempt to screen in beer drinkers (Ostafin & Palfai, 2006). Nonetheless, future research may benefit by examining whether idiosyncratic labels and stimuli improve the validity of the IAT.

As indicated in the opening quote, behavioral dyscontrol is an age-old dilemma. The present study contributes to the understanding of dyscontrol as it occurs in alcohol consumption. Specifically, the current results indicate dyscontrolled alcohol use is a function both of self-control resources and of automatic appetitive responses to alcohol.

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References


