Self-Control and Implicit Drinking Identity as Predictors of Alcohol Consumption, Problems, and Cravings

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ABSTRACT. Objective: We investigated trait and alcohol-specific self-control as unique predictors and moderators of the relation between implicit drinking identity associations and drinking. **Method:** Three hundred undergraduates completed a drinking identity Implicit Association Test (IAT), trait and alcohol self-control questionnaires, and alcohol consumption, problems, and cravings inventories. **Results:** Regression analyses tested for unique effects of predictors and for Self-Control × IAT interactions. Each predictor accounted for unique variance in consumption, but there was no evidence of moderation effects. Both types of self-control, but not IAT scores, accounted for unique variance in problems. A Trait Self-Control × Implicit Drinking interaction accounted for excess zeros in problems, with a greater likelihood of not having alcohol problems among individuals with low implicit identity who had higher versus lower trait self-control. Each predictor accounted for unique variance in cravings. A Trait Self-Control × IAT interaction was also found, indicating that implicit drinking identity was a stronger predictor of cravings among those with lower versus higher trait self-control. **Conclusions:** Results are partially consistent with previous research: Both types of self-control and drinking identity associations predicted unique variance in drinking, and moderation effects were observed for trait self-control and drinking identity associations and two of the three drinking variables. Findings suggest that trait and alcohol-specific self-control and implicit drinking identity could be useful intervention targets. (*J. Stud. Alcohol Drugs, 75,* 290–298, 2014)

THERE HAS BEEN CONSIDERABLE INTEREST in the role of implicit associations—that is, associations stemming from cognitive processes that are faster, more reflexive, and possibly less controllable—in hazardous drinking (Stacy and Wiers, 2010; Wiers and Stacy, 2006). As research interest in implicit associations has developed, there has been increased attention focused on elucidating the conditions under which implicit associations have more or less influence on impulsive behaviors, including drinking (Hofmann et al., 2008, 2009a, 2009b). The present study examined individual differences in self-control, which not only are important predictors of drinking (e.g., Collins and Lapp, 1991, 1992; Connors et al., 1998) but also have been shown to moderate the relationship between implicit associations and drinking (e.g., Burton et al., 2012; Friese and Hofmann, 2009; Hofmann et al., 2008). We focused on the constructs of general or trait self-control and alcohol-specific ("alcohol") self-control and investigated their roles in predicting alcohol-related variables (consumption, problems, and cravings). Further, we tested them as moderators of the relationship between one type of implicit associations (i.e., associations about the self and drinking; Gray et al., 2011; Lindgren et al., 2013a, 2013b) and alcohol-related variables.

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Dual-process models, implicit associations, and drinking

Implicit associations about alcohol (e.g., associations about drinking and the self, alcohol and valence, alcohol and appetitive inclinations) have been found to predict unique variance in drinking variables, including alcohol consumption, alcohol cravings, and alcohol-related problems (Greenwald et al., 2009; Lindgren et al., 2013b; Reich et al., 2010). These associations are commonly considered from the vantage of dual-process models (e.g., Stacy and Wiers, 2010; Wiers and Stacy, 2006), which consider both slow/reflective/controlled cognitive processes and fast/reflexive/impulsive processes to be influential on behavior, including drinking. According to dual-process models, these implicit processes and associations are thought to be triggered when alcohol-related stimuli are encountered, which then interact with conscious, reflective processes to lead the individual to either indulge in or inhibit the urge to drink. They may

be particularly helpful in explaining behavior driven by impulsive, relatively uncontrolled reactions or behavior that participants may be reluctant to report, such as hazardous drinking.

Although a variety of implicit alcohol-related associations have been investigated, implicit drinking identity associations (e.g., associations with the self and drinking or with the self and alcohol) have recently emerged as promising predictors of risky drinking behavior in young adults (Gray et al., 2011; Lindgren et al., 2013a, 2013b). The emphasis on drinking identity stems from a reformulation of the theory of planned behavior (original: Ajzen, 1991; reformulation: Fekadu and Kraft, 2001) that posited and ultimately demonstrated that including measures of how strongly one identifies with a (hazardous) behavior increases the predictability of that behavior. With respect to implicit drinking identity specifically, three recent studies (e.g., Gray et al., 2011; Lindgren et al., 2013a, 2013b) of undergraduates in three different regions of the United States have found support for implicit drinking identity as a unique predictor of alcohol-related outcomes. Moreover, the two studies by Lindgren et al. (2013a, 2013b) also found that implicit drinking identity associations, when compared with other implicit alcohol-related associations, were the strongest and most consistent predictors of alcohol-related outcomes (e.g., self-reported consumption, cravings, and problems). Notably, although implicit drinking identity associations appear promising, they are a recent development, and potential moderators, such as self-control, have not yet been investigated.

Dual-process models, self-control, and drinking

Dual-process models argue not only that impulsive processes play an important role in alcohol use but also that control processes are influential. Indeed, studies have shown that alcohol use is associated with disinhibition (e.g., Sher et al., 2000). It has been argued that impulsivity and disinhibition function as both a consequence and a determinant of drug use (de Wit, 2009; Verdejo-García et al., 2008). That is, disinhibition seems partly the result of acute (e.g., Field et al., 2010; Fillmore and Vogel-Sprott, 2006) and more chronic effects (Lubman et al., 2004) of heavy alcohol use on control processes. In addition, there is a body of research that suggests that low levels of self-control are partly a cause of alcohol use and alcohol use problems (Sher et al., 2000; Sher and Trull, 1994). A large-scale longitudinal study revealed, for example, that measures of behavioral disinhibition assessed at age 11 predicted drinking onset at age 14 (McGue et al., 2001), and a review study about the role of impulsivity and disinhibition concluded that impulsivity is a preexisting vulnerability marker for substance use (Verdejo-García et al., 2008). Finally, further support for the importance of self-control has come from additional studies that have found that self-reported measures of the difficulty of controlling alcohol intake predicted alcohol consumption (e.g., maximum amount consumed and weekend drinking; Collins et al., 1989). Thus, low levels of self-control seem to contribute to the initiation and levels of alcohol consumption.

Self-control as a moderator of implicit associations

Recent findings (Farris et al., 2010; Friese and Hofmann, 2009) have revealed that self-control also plays a role in drinking behavior through its regulation of impulsive processes. Specific to dual-process models, self-control has also been theorized to play a role in drinking behavior through its regulation of impulsive processes on alcohol use (Hofmann et al., 2008; Wiers and Stacy, 2006). Stated simply, self-control has been proposed as a moderator of the impact of implicit processes, including implicit associations, on alcohol use. Indeed, cross-sectional and longitudinal studies have shown that implicit alcohol associations predicted drinking behavior in individuals with low self-control but not in individuals with high self-control (e.g., Burton et al., 2012; Farris et al., 2010; Friese and Hofmann, 2009). Experimental studies have also demonstrated that there is a stronger (positive) relationship between implicit associations and drinking among participants whose self-control has been depleted compared with participants whose self-control has not been depleted (e.g., Friese et al., 2008, Study 3). Thus, in addition to a direct influence of self-control on drinking behavior, there also appears to be an indirect effect of self-control, with self-control moderating the influence of implicit processes on drinking.

Study purpose and overview

Both theory and initial findings, therefore, have supported self-control as a moderator of the influence of implicit associations on drinking. However, important gaps remain. Specifically, published studies that investigate both self-control and implicit processes tend to focus on a broader or more general construct of self-control. That is, studies to date have used measures that assess participants' success (or lack thereof) in keeping from doing *something* but that do not specify what that *something* is (emphasis added). Such studies and measures are extremely useful for investigating general individual differences in self-control and have helped to elucidate which aspects of general self-control are influential (e.g., Burton et al., 2012), but they cannot address questions regarding the influence or associations of domain-specific self-control. For example, it is unknown whether one's capability (or lack thereof) to control one's drinking (alcohol-specific self-control) might be a moderator of implicit associations. Similarly, published moderator studies have focused on implicit alcohol appetitive (approach vs. avoid) associations or implicit alcohol valence (pleasant vs. unpleasant, pleasant vs. neutral, unpleasant vs. neutral) as-

sociations (Burton et al., 2012; Farris et al., 2010; Friese and Hofmann, 2009; Friese et al., 2008), but there is emerging evidence for other implicit alcohol associations (e.g., implicit drinking identity associations) as important predictors of alcohol use and problems (Lindgren et al., 2013a, 2013b). Therefore, the aims of the current study were to investigate (a) whether trait self-control, alcohol-specific self-control, and implicit drinking identity associations are unique predictors of drinking when evaluated simultaneously and (b) whether both indices of self-control moderate the relation between implicit associations on drinking behavior. We expected that both indices of self-control and implicit drinking identity associations would be significantly and positively associated with drinking (e.g., measures of self-reported alcohol consumption, problems, and cravings). Based on dual-process models, we further expected that implicit drinking identity associations would be moderated by self-control, such that those associations would predict drinking outcomes more strongly in individuals with low self-control (trait and alcohol-specific) than in individuals with high self-control.

Method

Human subjects and institutional review board

All procedures and measures were reviewed and approved by the University of Washington's Institutional Review Board. Participants were guided through informed consent procedures by trained undergraduate experimenters and provided written informed consent.

Participants

Participants were 300 undergraduates (136 men, 164 women) between ages 18 and 25 years (M = 20.47, SD = 1.52). Fifty-seven percent of participants identified as White, 30% as Asian, 9% as multiracial, and the remaining 4% as either Black/African American, American Indian/Alaska Native, Native Hawaiian/other Pacific Islander, unknown, or declined to answer.

Measures

Implicit drinking identity. Implicit drinking identity was measured using the Implicit Association Test (IAT; Greenwald et al., 1998), a reaction time measure in which participants classify stimuli in order to measure their relative association strengths between two sets of target and attribute categories. Classification is expected to be faster when the pairing of the target and attribute categories corresponds to participants' associations in memory. The drinking identity IAT had seven blocks and measured associations between the concepts of *me* and *not me* and *drinker* versus *nondrinker.* Target labels and stimuli were me (me, my, mine, self) and not me (they, them, theirs, others); attribute labels and stimuli were drinker (drinker, partier, drink, drunk) and nondrinker (nondrinker, abstainer, sober, abstain). Blocks 1, 2, and 5 provided participants with practice classifying stimuli. There were two critical category-pairing conditions. In the first condition (Blocks 3 and 4), items representing the category *me* were categorized with the same response key as items representing the category *drinker*, and items representing *not me* were categorized with the same response key as items representing *nondrinker*. In the second condition (Blocks 6 and 7), this pairing was switched. The difference in average categorization latency across the two critical category-pairing conditions is interpreted as a relative preference for associating *me* with *drinker* versus *nondrinker*. Category pairings were counterbalanced and scores were calculated using the D score algorithm, such that higher scores represent stronger *me* and *drinker* associations (Greenwald et al., 2003).

Trait self-control. Trait self-control was measured with the 13-item Brief Self-Control Scale (Tangney et al., 2004). Items consist of negative (e.g., "I have a hard time breaking bad habits") and positive (e.g., "People would say that I have iron self-discipline") statements regarding self-control. Participants are asked to rate the applicability of each statement on a 5-point scale ranging from 1 (*not at all*) to 5 (*very much*). Consistent with Tangney et al., the measure was scored such that higher scores indicated higher levels of self-control. One item of the scale, "Pleasure and fun sometimes keep me from getting work done," was inadvertently omitted because of a programming error. Despite this omission, scale reliability was good (α = .82) and was consistent with the Cronbach's α value reported in Tangney et al.'s (2004) original validation article.

Alcohol self-control. Alcohol self-control was measured by the govern subscale of the Temptation and Restraint Inventory (Collins and Lapp, 1992). The govern subscale consists of three items (e.g., "How much difficulty do you have controlling your drinking?") and measures difficulty controlling alcohol consumption. Participants respond on a 9-point scale ranging from 1 (*not at all* or *never*) to 9 (*extremely* or *always*). This measure has been found to have good convergent and discriminant validity (Collins et al., 2000). Alpha for this sample was .85. To be consistent with the direction of the trait self-control scores and aid in the interpretation of findings, the alcohol self-control measure was scored such that higher scores indicated less difficulty controlling one's drinking or greater alcohol self-control.

Drinks per week. Drinks per week was measured by the Daily Drinking Questionnaire (Collins et al., 1985), which assesses average alcohol consumption during the past 3 months. Participants report how many standard drinks they consumed on each day of a typical week. Participants were provided with a card with common standard drink equivalencies. This is a widely used measure that has previously dem-

Table 1. Zero-order correlations and descriptive statistics for study variables ($N = 300$)

Variable	1.	2.	3.	4.	5.	6.	*M*	*SD*
1. Drinking identity IAT	–	-.19**	-.20**	.32***	.23***	.28***	0.04	0.39
2. Trait self-control		–	.42***	-.29***	-.46***	-.39***	3.34	0.69
3. Alcohol self-control			–	-.40***	-.61***	-.44***	7.89	1.58
4. Alcohol consumption				–	.64***	.41***	8.22	9.96
5. Alcohol problems					–	.48***	4.32	6.62
6. Alcohol cravings						–	20.33	10.18

*Notes: N*s vary slightly for each cell. For all variables, higher scores equal greater levels of the variable as it is named. For example, higher scores on trait self-control indicate higher mean levels of trait self-control, and higher scores on alcohol self-control indicate less difficulty controlling one's drinking or greater alcohol-specific self-control. IAT = Implicit Association Test; trait self-control = Brief Self-Control Scale; alcohol self-control = govern subscale of the Temptation and Restraint Inventory; alcohol consumption = Daily Drinking Questionnaire drinks per week; alcohol problems = Rutgers Alcohol Problems Index; alcohol cravings = Alcohol Cravings Questionnaire–Short Form–Revised.
**$p < .10$; ***$p < .001$.

onstrated good test–retest reliability and convergent validity with other measures (e.g., Marlatt et al., 1998; Neighbors et al., 2006). Alpha was .79.

Alcohol problems. Alcohol problems were measured with the Rutgers Alcohol Problem Index (RAPI; White and Labouvie, 1989). Participants report how many times in the past 3 months (from 0 = *never* to 4 = *more than 10 times*) they experienced 23 symptoms of problem drinking and negative consequences as a result of drinking, ranging from mild ("Had a bad time") to serious ("Suddenly found yourself in a place that you could not remember getting to"). Two additional items were added asking participants how often they had driven shortly after consuming two and four drinks, respectively. This measure has been found to have good test–retest reliability and convergent validity with related measures (e.g., Marlatt et al., 1998; Miller et al., 2002). Alpha was .90.

Alcohol cravings. Cravings were assessed using the Alcohol Craving Questionnaire Short Form–Revised (ACQ-SF-R), a short form of the Alcohol Craving Questionnaire (ACQ-NOW; Singleton et al., 2004). The ACQ-SF-R has moderate to strong reliability and validity (Drobes and Thomas, 1999) and consists of the 12 items of ACQ-NOW that correlate most strongly with the total ACQ-NOW score. The 12 items measured current alcohol cravings (e.g., "If I had some alcohol I would probably drink it"). Responses were measured on a 7-point scale ranging from 0 (*strongly disagree*) to 6 (*strongly agree*). Alpha for the current sample was .72.

Procedures

Participants were recruited by email and were invited to participate in a study about cognitive processes and alcohol. Study procedures were completed in the laboratory. Participants completed written informed consent procedures and responded to study measures via the computer. IATs and self-report questionnaires were presented in random order as part of a larger study validating several implicit measures as predictors of alcohol problems, consumption, and cravings (e.g., Lindgren et al., 2013b). Participants were compensated $30.

Results

Descriptive statistics

Table 1 presents zero-order correlations and descriptive statistics for study variables. As expected, both trait measures of self-control and alcohol-specific measures of self-control were correlated with drinking identity IAT scores and the alcohol variables. Both trait and alcohol-specific self-control scores were negatively correlated with alcohol variables, indicating that greater self-control was associated with lower drinking identity IAT scores, lower alcohol consumption, lower alcohol-related problems, and lower cravings scores. Control scores were moderately and positively correlated with one another.

Regression analysis

Preliminary analysis of the data revealed that the distribution of alcohol variables other than cravings deviated substantially from normal. Specifically, the distributions of the consumption and problems variables revealed a large number of zero responses followed by scores that approximated a negative binomial distribution. Accordingly, a count regression approach was used (Hilbe, 2011). These models allow one to fit an increasing range of distributions (Cohen et al., 2003). We used a zero-inflated negative binomial (ZINB) regression with a log link. Briefly, this approach involves performing two simultaneous tests for the model—one for a logistic portion predicting excess zeros and one for counts (the negative binomial portion). A separate output is generated for each portion. The logistic portion of the model functions similarly to a logistic regression by testing for

associations of each predictor with "always zero" versus all other scores on the dependent variable (e.g., the absence of alcohol consumption or presence of alcohol consumption) and provides a test for the excess zeros (zero inflation) in the dependent variable. The counts portion of the model tests for associations of each predictor with the full range of the binomial distribution, including zeros (Atkins and Gallop, 2007; Hilbe, 2011).

All regression models—ZINB and ordinary least squares—used the same approach where predictors were mean centered to facilitate interpretation. Two-way interaction terms for the IAT and the self-control variables were created by multiplying each centered control variable by the centered IAT score. Gender was dummy coded (0 = men, 1 = women) and was included as a covariate to account for differences in drinking between men and women (Johnston et al., 2013). All terms were entered simultaneously.

Alcohol consumption. Model fit for the ZINB analysis was good, Pearson $\chi^2(279) = 303.61$, with a value/*df* ratio of 1.09. Values close to 1 are considered to indicate a good fit for the model (Hilbe, 2011). Results for the logistic portion of the model, which fits the excess zeros, indicated only a significant main effect for alcohol self-control, with greater self-control (or less difficulty controlling one's drinking) being associated with a greater likelihood of no alcohol consumption. In other words, greater alcohol self-control was associated with greater odds of not drinking. Results for the counts portion of the model indicated significant main effects for drinking identity, trait self-control, and alcohol self-control. All main effects were in the expected direction such that greater identification with drinking, lower trait self-control, and lower alcohol self-control were associated with more alcohol consumption. Contrary to expectations, neither type of self-control significantly moderated the impact of drinking identity on alcohol consumption (Table 2).

Alcohol-related problems. Model fit for the ZINB analysis was good, Pearson $\chi^2(279) = 286.94$, with a value/*df* ratio of 1.03. Results for the logistic portion of the model indicated significant main effects for both self-control variables, with greater trait self-control and greater alcohol self-control associated with the absence of alcohol-related problems. Drinking identity was also found to moderate trait self-control. As shown in Figure 1a, trait self-control did not appear to affect alcohol problems at higher levels of implicit drinking identity. However, at lower levels of implicit drinking identity, participants were more likely to have an absence of (or zero) alcohol problems if they had higher versus lower trait self-control. Results for the counts portion of the model indicated significant main effects for trait self-control and alcohol self-control. Both main effects were in the predicted direction, with lower trait self-control and lower alcohol control associated with greater numbers of alcohol-related problems. Contrary to expectations, neither type of self-control significantly moderated drinking identity nor was implicit drinking identity a unique predictor of alcohol problems (Table 2).

Table 2. Regression results examining alcohol variables as a function of drinking identity IAT, trait self-control, and alcohol self-control

Predictor	*B*	*SE B*	Wald χ^2 or *t*
Alcohol consumption			
Logistic portion of model			
Gender	-0.33	0.42	0.62
Drinking identity IAT	-7.87	7.58	1.08
Trait self-control	0.11	0.31	0.12
Alcohol self-control	9.91	4.47	4.91*
Trait Self-Control × IAT	1.08	0.82	1.74
Alcohol Self-Control × IAT	6.34	6.89	0.85
Counts portion of model			
Gender	-0.36	0.11	10.32**
Drinking identity IAT	0.64	0.15	18.33***
Trait self-control	-0.23	0.09	6.53*
Alcohol self-control	-0.14	0.04	11.37***
Trait Self-Control × IAT	0.37	0.21	3.00
Alcohol Self-Control × IAT	-0.08	0.10	0.62
Alcohol problems			
Logistic portion of model			
Gender	-0.86	0.59	2.08
Drinking identity IAT	-7.88	5.45	2.09
Trait self-control	1.74	0.57	9.35**
Alcohol self-control	6.39	2.90	4.84*
Trait Self-Control × IAT	3.02	1.30	5.39*
Alcohol Self-Control × IAT	5.52	4.95	1.25
Counts portion of model			
Gender	-0.07	0.13	0.32
Drinking identity IAT	0.24	0.19	1.63
Trait self-control	-0.39	0.11	12.23***
Alcohol self-control	-0.28	0.05	37.01***
Trait Self-Control × IAT	-0.22	0.27	0.65
Alcohol Self-Control × IAT	0.12	0.11	1.26
Alcohol cravings			
Gender	-0.62	1.05	-0.59
Drinking identity IAT	4.63	1.37	3.39**
Trait self-control	-3.36	0.82	-4.08***
Alcohol self-control	-2.03	0.37	-5.53***
Trait Self-Control × IAT	-4.82	2.05	-2.39*
Alcohol Self-Control × IAT	1.07	0.94	1.13

Notes: All predictors other than gender were grand-mean centered. Gender was included as a covariate and was dummy coded, 0 = male, 1 = female. Alcohol consumption and problems models used zero-inflated regression models with a negative binomial log link. Alcohol cravings used ordinary least squares regression. IAT = Implicit Association Test.
*$p < .05$; **$p < .01$; ***$p < .001$.

An exploratory model was also run to address possible concerns regarding criterion contamination. Several items in the RAPI concern controlling drinking and/or imply a failure to control one's drinking. A new summary RAPI score was created without those four items (e.g., "tried to control drinking by trying to drink only at certain times," "had withdrawal symptoms . . . because you stopped or cut down," "tried to cut down or quit drinking," and "kept drinking when you promised yourself not to"), and the model was rerun. That model had a similarly good fit. The coefficient estimates were very similar, and the pattern of results with respect to significance levels was identical.

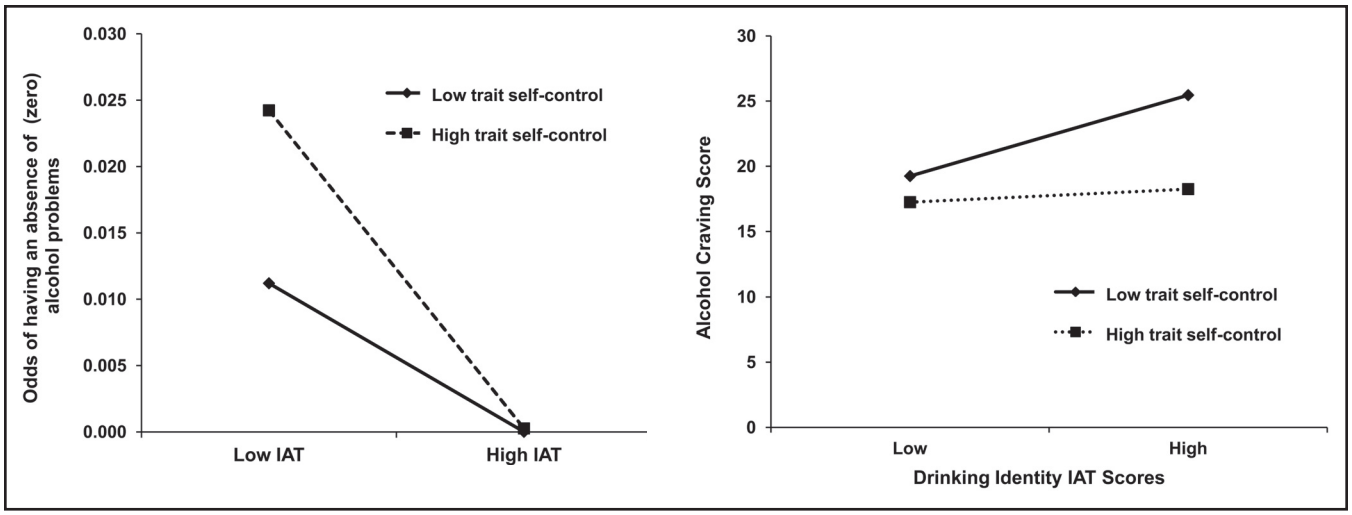

FIGURE 1. (a) Plot of the interaction of trait self-control and drinking identity Implicit Association Test (IAT) scores predicting the odds of having an absence of (or zero) alcohol-related problems. Low and high values of trait self-control and IAT scores represent ±1 *SD* from the mean. (b) Plot of the interaction of trait self-control and drinking identity IAT scores predicting alcohol cravings. Higher values indicate greater alcohol cravings. Low and high values of trait self-control and IAT scores represent ±1 *SD* from the mean.

Alcohol cravings. The effects of the predictors on alcohol cravings were examined using ordinary least squares regression. Results for the overall model indicated that the predictors accounted for 29% of the variance in cravings. As predicted, significant main effects were observed for drinking identity, trait self-control, and alcohol self-control, and they were in the expected direction (Table 2). The predicted interaction between drinking identity and trait self-control was significant. Consistent with expectations, drinking identity IAT scores predicted alcohol cravings more strongly for participants with lower versus higher levels of trait self-control (Figure 1b).

Discussion

Results were partially consistent with expectations. Drinking identity, trait self-control, and alcohol self-control were related to the alcohol variables in the expected direction. The drinking identity IAT was somewhat less strongly associated with the alcohol variables compared with the self-control variables, and it was not uniquely associated with alcohol problems when it was evaluated in regression models that included both types of self-control. Both trait and alcohol self-control were uniquely associated with all three alcohol variables. Some support was found for trait self-control, but not alcohol self-control, as a moderator of the association between the drinking identity IAT and the different drinking variables. Although no support was evident for trait self-control as a moderator of the association between the IAT and alcohol consumption, the drinking identity IAT was more strongly associated with alcohol cravings at lower levels of self-control. In addition, a small moderation effect was observed for the excess zeros in alcohol problems, with higher versus lower trait self-control being associated with greater odds of not having alcohol problems at lower levels of alcohol identity. In essence, this finding could be characterized as preliminary evidence of a protective effect such that participants with more self-control and lower identification with drinking are less likely to have alcohol problems. The current findings were, thus, most consistent with previous research on the direct role of self-control in predicting alcohol variables (e.g., Collins and Lapp, 1992; Collins et al., 1989; McGue et al., 2001) and extended those findings by considering both trait and alcohol-related self-control simultaneously and evaluating their associations with alcohol variables.

On the other hand, our findings were only partially consistent with dual-process models suggesting that self-control would moderate the relationship between implicit associations and drinking. Although trait self-control moderated the relationship between alcohol associations and cravings and problems in our study, it did not moderate the relationship with alcohol consumption. Furthermore, contrary to expectations, alcohol-specific self-control did not moderate the relationship between alcohol associations and any of the alcohol variables.

We can only provide limited information and some speculation as to why our findings indicate, at best, partial support for moderation effects. First, one might speculate the null findings are a reflection of our study measures. The trait and alcohol-specific self-control measures were correlated with each other at .42; thus, they share nearly 20% of their variance. This covariance will make it a more difficult test when the trait and alcohol-specific self-control measures are

simultaneously evaluated in regression models. However, we did conduct supplemental analyses to examine whether models that considered each type of self-control separately would yield any additional evidence of moderation. They did not. Thus, the overlapping variance does not appear to be a crucial factor in this sample. Second, considering moderators of the relation between implicit associations and drinking is a relatively new field of research. We know of only a few published studies that have tested the interaction of self-reported measures of self-control and implicit alcohol associations with respect to self-report measures of drinking (e.g., Burton et al., 2012; Farris et al., 2010; Friese and Hofmann, 2009). Each of these studies, as well as the current study, differed in terms of samples (e.g., U.S. vs. European samples, including nondrinkers or not) and measures (e.g., the measures of self-control, the measures of implicit associations as well as the content of the associations evaluated, and the measures of drinking), and those differences could account for the contradictory findings. For example, Friese and Hofmann (2009) also observed occasional inconsistent findings: trait self-control moderated the relationship between alcohol associations (as measured by a single-category variant of the IAT) and alcohol consumption in an ordinary drinking occasion and in the previous week in their Study 2a, but in Study 2b it was not a significant moderator of the relationship between alcohol associations (as measured by the affect misattribution procedure; Payne et al., 2005) on alcohol consumption in the previous week. Finally, it may also be that the self-control process is more likely to moderate the relation between implicit associations and alcohol variables when those alcohol variables are more proximal (e.g., current cravings, alcohol consumption in the laboratory) versus more distal (e.g., typical alcohol consumption over the last 3 months). Thus, it will be important for future studies to clarify the influences of method, measures, and participant populations.

Implications

This study adds to the literature supporting alcohol-related IATs, including the drinking identity IAT, and measures of self-control as promising predictors of alcohol-related variables. In particular, study results provide some boundary conditions for associations between implicit drinking identity and problematic drinking and suggest that these associations may be especially important among those who have more difficulty controlling their behavior. Thus, the present research suggests that interventions aimed at reducing problematic drinking by modifying implicit associations using a computer-based training task (e.g., Wiers et al., 2011) may be most effective among those with deficits in trait self-control. This suggestion is also supported by findings in the field of anxiety that individuals with low levels of trait control benefit the most from such a training (Salemink and Wiers, 2012). Alternatively, interventions that directly target self-control, at either the trait or alcohol-specific level, may be fruitful in directly affecting drinking or affecting the influence of implicit processes on drinking. Supporting this notion, a recent study revealed that a working memory training task increased control over automatic alcohol-related impulses in problem drinkers and resulted in reduced alcohol intake up to 1 month after training (Houben et al., 2011a). Research also supports targeting alcohol-specific self-control as a potential intervention; for example, findings from another study found that strengthening response inhibition for alcohol cues reduced weekly alcohol intake in heavy drinking students (Houben et al., 2011b).

Limitations and future directions

There are several limitations to the present study. First, the cross-sectional design limits our ability to draw causal influences. Findings from the current study are consistent with implicit drinking identity and self-control serving as antecedents of problem drinking but are equally consistent with the reverse causal direction. Moreover, there may be bidirectional associations among them. Longitudinal research examining temporal precedence will be valuable. Furthermore, experimental research investigating changes in drinking following manipulations of implicit drinking identity and/or self-control will have direct clinical implications. The current data are also limited by the sample, which consisted of college students. It will be helpful to study clinical populations with greater variability in drinking identity and severity of deficits in self-control. In addition, although reliability was good and consistent with those establishing the psychometric properties of the measure (e.g., Tangney et al., 2004), the inadvertent omission of an item of the trait self-control measure is a limitation. Finally, the present study used well-established, well-validated measures (trait and alcohol-specific) of self-control, but whether findings will hold with alternative, related, or reaction time–based measures of self-control should be investigated. For example, trait self-control has considerable conceptual overlap with impulsivity. Testing whether impulsivity and specific subdimensions of impulsivity moderate the association between implicit drinking identity and drinking variables will be useful.

Conclusion

Ultimately, the current study extends research on self-control as a moderator of implicit associations by evaluating both general (trait) and domain-specific (alcohol) self-control as well as by considering implicit drinking identity associations. Results were partially consistent with predictions: on the one hand, control and implicit associations were related to all of the alcohol variables and predicted unique variance; on the other hand, support for moderation was mixed. Col-

lectively, however, the findings provide support for future research that clarifies how participant samples and research methods might influence moderation effects as well as for interventions that specifically target self-control and/or implicit associations.

References

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50,* 179–211.

Atkins, D. C., & Gallop, R. J. (2007). Rethinking how family researchers model infrequent outcomes: A tutorial on count regression and zero-inflated models. *Journal of Family Psychology, 21,* 726–735.

Burton, C. M., Pedersen, S. L., & McCarthy, D. M. (2012). Impulsivity moderates the relationship between implicit associations about alcohol and alcohol use. *Psychology of Addictive Behaviors, 26,* 766–772.

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences* (3rd ed.). Mahwah, NJ: Lawrence Erlbaum Associates.

Collins, R. L., George, W. H., & Lapp, W. M. (1989). Drinking restraint: Refinement of a construct and prediction of alcohol consumption. *Cognitive Therapy and Research, 13,* 423–440.

Collins, R. L., Koutsky, J. R., & Izzo, C. V. (2000). Temptation, restriction, and the regulation of alcohol intake: Validity and utility of the Temptation and Restraint Inventory. *Journal of Studies on Alcohol, 61,* 766–773.

Collins, R. L., & Lapp, W. M. (1991). Restraint and attributions: Evidence of the abstinence violation effect in alcohol consumption. *Cognitive Therapy and Research, 15,* 69–84.

Collins, R. L., & Lapp, W. M. (1992). The Temptation and Restraint Inventory for measuring drinking restraint. *British Journal of Addiction, 87,* 625–633.

Collins, R. L., Parks, G. A., & Marlatt, G. A. (1985). Social determinants of alcohol consumption: The effects of social interaction and model status on the self-administration of alcohol. *Journal of Consulting and Clinical Psychology, 53,* 189–200.

Connors, G. J., Collins, R. L., Dermen, K. H., & Koutsky, J. R. (1998). Substance use restraint: An extension of the construct to a clinical population. *Cognitive Therapy and Research, 22,* 75–87.

de Wit, H. (2009). Impulsivity as a determinant and consequence of drug use: A review of underlying processes. *Addiction Biology, 14,* 22–31.

Drobes, D. J., & Thomas, S. E. (1999). Assessing craving for alcohol. *Alcohol Research & Health, 23,* 179–186.

Farris, S. R., Ostafin, B. D., & Palfai, T. P. (2010). Distractibility moderates the relation between automatic alcohol motivation and drinking behavior. *Psychology of Addictive Behaviors, 24,* 151–156.

Fekadu, Z., & Kraft, P. (2001). Self-identity in planned behavior perspective: Past behavior and its moderating effects on self-identity-intention relations. *Social Behavior and Personality: An International Journal, 29,* 671–685.

Field, M., Wiers, R. W., Christiansen, P., Fillmore, M. T., & Verster, J. C. (2010). Acute alcohol effects on inhibitory control and implicit cognition: Implications for loss of control over drinking. *Alcoholism: Clinical and Experimental Research, 34,* 1346–1352.

Fillmore, M. T., & Vogel-Sprott, M. (2006). Acute effects of alcohol and other drugs on automatic and intentional control. In R. W. Wiers, & A. W. Stacy (Eds.), *Handbook of implicit cognition and addiction* (pp. 293–306). Thousand Oaks, CA: Sage.

Friese, M., & Hofmann, W. (2009). Control me, or I will control you: Impulses, trait self-control, and the guidance of behavior. *Journal of Research in Personality, 43,* 795–805.

Friese, M., Hofmann, W., & Wänke, M. (2008). When impulses take over: Moderated predictive validity of explicit and implicit attitude measures in predicting food choice and consumption behaviour. *British Journal of Social Psychology, 47,* 397–419.

Gray, H. M., LaPlante, D. A., Bannon, B. L., Ambady, N., & Shaffer, H. J. (2011). Development and validation of the Alcohol Identity Implicit Associations Test (AI-IAT). *Addictive Behaviors, 36,* 919–926.

Greenwald, A. G., McGhee, D. E., & Schwartz, J. K. L. (1998). Measuring individual differences in implicit cognition: The Implicit Association Test. *Journal of Personality and Social Psychology, 74,* 1464–1480.

Greenwald, A. G., Nosek, B. A., & Banaji, M. R. (2003). Understanding and using the Implicit Association Test: I. An improved scoring algorithm. *Journal of Personality and Social Psychology, 85,* 197–216.

Greenwald, A. G., Poehlman, T. A., Uhlmann, E., & Banaji, M. R. (2009). Understanding and using the Implicit Association Test: III. Meta-analysis of predictive validity. *Journal of Personality and Social Psychology, 97,* 17–41.

Hilbe, J. M. (2011). *Negative binomial regression* (2nd ed.). New York, NY: Cambridge University Press.

Hofmann, W., Friese, M., & Roefs, A. (2009a). Three ways to resist temptation: The independent contributions of executive attention, inhibitory control, and affect regulation on the impulse control of eating behavior. *Journal of Experimental Social Psychology, 45,* 431–435.

Hofmann, W., Friese, M., & Strack, F. (2009b). Impulse and self-control from a dual-systems perspective. *Perspectives on Psychological Science, 4,* 162–176.

Hofmann, W., Friese, M., & Wiers, R. W. (2008). Impulsive versus reflective influences on health behavior: A theoretical framework and empirical review. *Health Psychology Review, 2,* 111–137.

Houben, K., Nederkoorn, C., Wiers, R. W., & Jansen, A. (2011a). Resisting temptation: Decreasing alcohol-related affect and drinking behavior by training response inhibition. *Drug and Alcohol Dependence, 116,* 132–136.

Houben, K., Wiers, R. W., & Jansen, A. (2011b). Getting a grip on drinking behavior: Training working memory to reduce alcohol abuse. *Psychological Science, 22,* 968–975.

Johnston, L. D., O'Malley, P. M., Bachman, J. G., & Schulenberg, J. E. (2013). *Monitoring the Future national survey results on drug use, 1975-2012: Volume 2, College students and adults ages 19–50.* Ann Arbor, MI: Institute for Social Research, The University of Michigan.

Lindgren, K. P., Foster, D. W., Westgate, E. C., & Neighbors, C. (2013a). Implicit drinking identity: Drinker+me associations predict college student drinking consistently. *Addictive Behaviors, 38,* 2163–2166.

Lindgren, K. P., Neighbors, C., Teachman, B. A., Wiers, R. W., Westgate, E., & Greenwald, A. G. (2013b). I drink, therefore I am: Validating alcohol-related implicit association tests. *Psychology of Addictive Behaviors, 27,* 1–13.

Lubman, D. I., Yücel, M., & Pantelis, C. (2004). Addiction, a condition of compulsive behaviour? Neuroimaging and neuropsychological evidence of inhibitory dysregulation. *Addiction, 99,* 1491–1502.

Marlatt, G. A., Baer, J. S., Kivlahan, D. R., Dimeff, L. A., Larimer, M. E., Quigley, L. A., . . . Williams, E. (1998). Screening and brief intervention for high-risk college student drinkers: Results from a 2-year follow-up assessment. *Journal of Consulting and Clinical Psychology, 66,* 604–615.

McGue, M., Iacono, W. G., Legrand, L. N., Malone, S., & Elkins, I. (2001). Origins and consequences of age at first drink. I. Associations with substance-use disorders, disinhibitory behavior and psychopathology, and P3 amplitude. *Alcoholism: Clinical and Experimental Research, 25,* 1156–1165.

Miller, E. T., Neal, D. J., Roberts, L. J., Baer, J. S., Cressler, S. O., Metrik, J., & Marlatt, G. A. (2002). Test-retest reliability of alcohol measures: Is there a difference between internet-based assessment and traditional methods? *Psychology of Addictive Behaviors, 16,* 56–63.

Neighbors, C., Dillard, A. J., Lewis, M. A., Bergstrom, R. L., & Neil, T. A.

(2006). Normative misperceptions and temporal precedence of perceived norms and drinking. *Journal of Studies on Alcohol, 67,* 290–299.

Payne, B. K., Cheng, C. M., Govorun, O., & Stewart, B. D. (2005). An inkblot for attitudes: Affect misattribution as implicit measurement. *Journal of Personality and Social Psychology, 89,* 277–293.

Reich, R. R., Below, M. C., & Goldman, M. S. (2010). Explicit and implicit measures of expectancy and related alcohol cognitions: A meta-analytic comparison. *Psychology of Addictive Behaviors, 24,* 13–25.

Salemink, E., & Wiers, R. W. (2012). Adolescent threat-related interpretive bias and its modification: The moderating role of regulatory control. *Behaviour Research and Therapy, 50,* 40–46.

Sher, K. J., Bartholow, B. D., & Wood, M. D. (2000). Personality and substance use disorders: A prospective study. *Journal of Consulting and Clinical Psychology, 68,* 818–829.

Sher, K. J., & Trull, T. J. (1994). Personality and disinhibitory psychopathology: Alcoholism and antisocial personality disorder. *Journal of Abnormal Psychology, 103,* 92–102.

Singleton, E. G., Tiffany, S. T., & Henningfield, J. E. (2004). *Manual. Alcohol Craving Questionnaire (ACQ-NOW): Background, Scoring, and Administration.* Unpublished manuscript, Division of Intramural Research, NIDA, NIH, Baltimore, MD, 1994, June (revised 1995, October; 1999, May; 2001, August; 2004, November), 1–28.

Stacy, A. W., & Wiers, R. W. (2010). Implicit cognition and addiction: A tool for explaining paradoxical behavior. *Annual Review of Clinical Psychology, 6,* 551–575.

Tangney, J. P., Baumeister, R. F., & Boone, A. L. (2004). High self-control predicts good adjustment, less pathology, better grades, and interpersonal success. *Journal of Personality, 72,* 271–324.

Verdejo-García, A., Lawrence, A. J., & Clark, L. (2008). Impulsivity as a vulnerability marker for substance-use disorders: Review of findings from high-risk research, problem gamblers and genetic association studies. *Neuroscience and Biobehavioral Reviews, 32,* 777–810.

White, H. R., & Labouvie, E. W. (1989). Towards the assessment of adolescent problem drinking. *Journal of Studies on Alcohol, 50,* 30–37.

Wiers, R. W., Eberl, C., Rinck, M., Becker, E. S., & Lindenmeyer, J. (2011). Retraining automatic action tendencies changes alcoholic patients' approach bias for alcohol and improves treatment outcome. *Psychological Science, 22,* 490–497.

Wiers, R. (Ed.), & Stacy, A. (Ed.). (2006). *Handbook of implicit cognition and addiction.* Thousand Oaks, CA: Sage.