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Habit doesn't make the predictions stronger: Implicit alcohol associations and habitualness predict drinking uniquely

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HIGHLIGHTS

- Does habitualness interact with implicit alcohol associations to predict drinking?
- We tested this in a study of 506 US undergraduates.
- Moderation was largely not supported.
- Habitualness and implicit alcohol association independently predicted drinking.
- Both are potential risk factors of hazardous drinking and targets for intervention.

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ABSTRACT

Introduction: As research on implicit (in the sense of fast/reflexive/impulsive) alcohol associations and alcohol advances, there is increasing emphasis on understanding the circumstances under which implicit alcohol associations predict drinking. In this study, we investigated habitualness of drinking (i.e., the extent to which drinking is automatic or occurs without thinking) as a moderator of the relations between several measures of implicit alcohol associations and key drinking outcomes.
Method: A sample of 506 participants (57% female) completed web-based measures of implicit alcohol associations (drinking identity, alcohol approach, and alcohol excitement), along with indicators of habitualness, and typical alcohol consumption, alcohol problems, and risk of alcohol use disorders.
Results: As expected, implicit alcohol associations, especially drinking identity, were positively associated with, and predicted unique variance in, drinking outcomes. Further, habitualness emerged as a consistent, positive predictor of drinking outcomes. Contrary to expectations, habitualness rarely moderated the relation between implicit alcohol associations and drinking outcomes.
Conclusions: Although moderation was rarely observed, findings indicated that even mild levels of habitualness are risky. Findings also continue to support implicit alcohol associations, particularly drinking identity, as a risk factor for hazardous drinking. Collectively, this suggests the importance of targeting both in prevention and intervention efforts.

1. Introduction

Implicit alcohol associations (i.e., associations that are more impulsive and reflexive than those measured via self-report questionnaires) are potential risk factors of and targets for hazardous drinking (see Stacy & Wiers, 2010; Wiers, Eberl, Rinck, Becker, & Lindenmeyer, 2011). As the field advances, it is important to identify the situations under which implicit alcohol associations will be more (or less) predictive of drinking. This is important theoretically (e.g., Hofmann, Friese, & Wiers, 2008)

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and for developing interventions. The extent to which drinking is habitual (i.e., automatic, occurring without "thinking") has been proposed, but not yet tested, as a moderator of the relationship between implicit alcohol associations and drinking. Therefore, we investigated habitualness as a potential moderator of the relationship between implicit alcohol associations and drinking.

Implicit alcohol associations are typically measured using so-called implicit measures, the most common of which is the Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998). The IAT has been adapted to evaluate a variety of alcohol-related associations, including alcohol and approach (e.g., Ostafin & Palfai, 2006), drinking and identity (e.g., Lindgren et al., 2013), and alcohol and excitement (e.g., Lindgren, Hendershot, Neighbors, Blayney, & Otto, 2011). These IATs predicted unique variance in a variety of drinking outcomes, including alcohol consumption, problems, risk of alcohol use disorders, and craving (see Lindgren, Foster, Westgate, & Neighbors, 2013; Lindgren, Neighbors, et al., 2013; Roefs et al., 2011). Although the majority of this research is cross-sectional, there is emerging evidence that implicit alcohol associations predict drinking prospectively (Lindgren, Neighbors, Wiers, Gasser, & Teachman, 2015; Stacy, 1997; Thush & Wiers, 2007) and that they can be targets for drinking interventions (Wiers, Gladwin, Hofmann, Salemink, & Ridderinkhof, 2013; Wiers et al., 2011).

One proposed moderator of the impact of implicit associations on behavior is habitualness (Hofmann et al., 2008). The proposed relationship is that as drinking becomes more habitual or under more automatic control, drinking will be better predicted by measures that capture more automatic alcohol-related processes (e.g., alcohol-related IATs). Although this relationship has not yet been tested, research in a different health domain (i.e., eating behaviors) has indicated that implicit measures better predicted consumption of sweets in more habitual sweet eaters (e.g., Conner, Perugini, O'Gorman, Ayres, & Prestwich, 2007).

Our primary goal was to evaluate habitualness as a moderator of the relationship between implicit alcohol associations and key drinking outcome variables (self-reported alcohol consumption, alcohol-related problems, and risk of alcohol use disorders). We focused on three implicit alcohol associations – implicit drinking identity, implicit alcohol approach associations, and implicit alcohol excite associations – that have predicted unique variance in drinking (Lindgren, Foster, Westgate, & Neighbors, 2013; Lindgren, Neighbors, et al., 2013; Roefs et al., 2011). We expected that those findings would replicate in the current sample. We assessed habitualness and expected that it would also be uniquely and positively associated with drinking outcomes. Finally, we evaluated the interaction of the implicit alcohol associations and habitualness and expected to find stronger relationships between implicit alcohol associations and drinking outcomes at higher levels of habitualness.

2. Method

2.1. Participants

The sample consisted of 506 undergraduates (214 men, 288 women, 2 transgender individuals, 2 who did not provide a response) who participated in an online study about cognitive processes and alcohol. Participants were between 18 and 20 years old ($M = 18.57$, $SD = .69$), in their first or second year of college, fluent in English, and recruited from a large public university in the Pacific Northwest. Fifty-two percent of participants identified themselves as White/Caucasian, 31% Asian, 11% multiracial, 1% African American, 1% American Indian/Alaska Native, and the remaining 4% answered unknown or did not respond. Twelve people were excluded from further analyses: two transgender individuals and two individuals whose gender was unreported (these individuals were excluded because of the need to control for gender in analyses), and eight individuals who made errors on two or more of the four questions designed to identify inattentive respondents.

2.2. Measures

2.2.1. IATs

Three Implicit Association Tests (IATs; Greenwald et al., 1998) were included to assess implicit alcohol associations. Detailed descriptions of the IAT can be found at Lindgren, Neighbors, et al. (2013). Briefly, each IAT had seven blocks: blocks 1, 2, and 5 were practice blocks that allowed participants to learn the task. The remaining blocks were the critical blocks. Those four test blocks consist of sorting stimuli items that represent the four concepts in each IAT (e.g., drinker, non-drinker, me, not me) using two response options (left or right). For example, stimuli belonging to the "drinker" or "me" concepts are sorted using a key on the left; stimuli belonging to the "non-drinker" or "not me" concepts are sorted using a key on the right. After two blocks containing multiple trials, the pairings are switched: stimuli belonging to the "drinker" or "not me" concepts are sorted using the left key; stimuli belonging to the "non-drinker" or "me" concepts are now sorted using the right key. The order of the pairings is counterbalanced across participants. The reaction times for the first pairing (e.g., "drinker" and "me" vs. "non-drinker" and "not me") is compared to the latter pairing ("non-drinker" and "me" vs. "drinker" and "not me") and serves as an index of the relative strength of implicit associations — e.g., shorter reaction times for the first pairing compared to the second would indicate a relatively stronger association with "drinker" and "me" (vs. "drinker" and "not me") or a stronger implicit drinking identity.

The drinking identity IAT (Lindgren, Neighbors, et al., 2013) evaluated the association of me (vs. not me) with drinker (vs. non-drinker). The approach-avoid IAT (Ostafin & Palfai, 2006) evaluated the association of alcohol (vs. water) with approach (vs. avoid). The excite-depress IAT (Lindgren et al., 2011, similar to Wiers, Van Woerden, Smulders, & De Jong, 2002) evaluated the association of alcohol (vs. water) with excite (vs. depress). For the alcohol-approach and alcohol-excite IATs, participants were asked to select four images (from a total of 15) of the alcohol that they drank the most (or, if they did not drink, that they were offered most). Those IATs used four standardized images of water. Please see Lindgren, Neighbors, et al. (2013) for the complete stimulus list for the three IATs. The order of the IATs was randomized.

Per the data cleaning practices outlined in Nosek, Greenwald, and Banaji (2007), IATs were not scored if 10% or more trials were faster than 300 ms or if 30% or more trials had errors (n = 26). IATs were scored using the D score algorithm (Greenwald, Nosek, & Banaji, 2003). D scores were calculated such that higher scores indicated stronger associations with drinker and me, alcohol and approach, or alcohol and excite, respectively. The internal consistencies for each IAT, derived by calculating and then correlating the D scores between IAT blocks 3 and 6 and blocks 4 and 7, were within the typical range of .5 to .7 (see Greenwald et al., 2003; drinking identity = .58, alcohol approach = .52, alcohol excite = .59).

2.2.2. Habitualness

A subset of questions from the Self-Report Index of Habit Strength (Verplanken & Orbell, 2003) was used to evaluate the habitualness of drinking. All items were administered, but items related to drinking quantity/frequency or dependency of drinking were excluded from analyses to reduce construct overlap. We retained items 2, 3, 5, 6, and 8 (e.g., "Drinking alcohol is something I do automatically," "Drinking alcohol is something I do without having to consciously remember"). The use of this subset versus the full scale reduced the correlations with the drinking outcomes (alcohol consumption: from .64 to .55; alcohol problems from .61 to .56; risk of alcohol use disorders from .75 to .66). Cronbach's alpha for this sample was .90.

2.2.2.1. Alcohol consumption. The Daily Drinking Questionnaire (DDQ: Collins, Parks, & Marlatt, 1985) measured daily alcohol consumption during a typical week over the last three months. Participants were

provided with definitions of standard drinks. Scores were computed by summing the reported quantities of standard drinks.

2.2.2.2. Alcohol-related problems. The Rutgers Alcohol Problems Index (RAPI: White & Labouvie, 1989) evaluated the frequency of 23 possible alcohol-related problems in the previous three months, such as neglecting one's responsibilities or missing a day of school or work, on a five-point scale ranging from 0 = "never" to 4 = "more than 10 times." Two questions were added to assess the frequency of driving shortly after two and four drinks. Cronbach's alpha was .90 for this sample.

2.2.2.3. Alcohol use disorders. The 10-item Alcohol Use Disorders Identification Test (AUDIT: Babor, Higgins-Biddle, Saunders, & Monteiro, 2001) assessed the risk of alcohol use disorders. Cronbach's alpha for this sample was .83.

2.3. Procedures

Procedures were approved by the appropriate university IRB. Participants were recruited via email. They were invited to participate in a two-year study about changes in implicit measures and drinking. The data described here come from the first assessment; data collection for the larger study is ongoing. Participants completed informed consent and the study measures and tasks (e.g., the three IATs) on the study website at a computer of their choice. Participants were compensated $25.

3. Results

3.1. Analytic strategy

The study's primary aim was to evaluate drinking habitualness as a moderator of the relationship between implicit alcohol associations (measured by the IAT) and drinking outcomes. We systematically examined three alcohol-related IATs (the drinking identity IAT, the alcohol approach IAT, and the alcohol excite IAT), and three drinking outcomes (alcohol consumption, alcohol problems, and risk of alcohol use disorders). This approach was taken to examine consistency of findings across the IATs and drinking outcomes. Although this approach may contribute to alpha inflation, our interpretations focus more on the pattern of results than on any specific test.

Zero-inflated Negative Binomial (ZINB) models were selected for analyses because the drinking outcomes were not normally distributed: each had a large proportion of zeroes and exhibited large positive skew.[1] ZINB models are designed to address distributions that have many zero response (i.e., "excess zeroes") and that have many people who score on the low end of the distribution. ZINB models essentially consist of two regression models, run simultaneously, that address both of these issues (Atkins & Gallop, 2007; Hilbe, 2011). There is a binary model that distinguishes excess zeroes (e.g., never drinkers versus everyone else). There is also a count portion of the model that represents the full range of scores in the outcome (e.g., number of drinks per week) but models that outcome using a negative binomial distribution (vs. a normal distribution). In the zero inflation portion of the model, parameter estimates are on a logit scale and predict the likelihood of being an excess zero (e.g., the likelihood of reporting no drinking, no drinking problems, or an AUDIT score of zero). Parameter estimates for the count portion of the model are expressed in natural log units.

Habitualness was operationalized as a dichotomous predictor (0 = none, 1 = any habit). We initially evaluated habitualness as a continuous predictor but the extreme skew of this variable (about half of the sample reported no habitualness) combined with the distribution of the drinking outcomes resulted in questionable fit for some of the models. Overall, conclusions were similar using either approach, but findings were more consistent and models consistently converged and had good fit when habitualness was specified as dichotomous.

ZINB models were conducted using the ZINB procedure in STATA 13.0. Each model was run in two steps. Step 1 included gender (coded 0 = men, 1 = women) and an IAT score. Step 2 added habitualness (coded 0 = no habit, 1 = any habit) to examine the unique effects of habitualness over and above the IAT score. Step 3 added the product of the IAT score and habitualness to examine the potential interaction between these variables to test the proposed moderation effects. We describe the results of each step, but for brevity, only the third step in the models is shown in Tables 2–4. Each IAT score was included as a predictor in three ZINB models where drinks per week, alcohol-related negative consequences, and AUDIT scores were operationalized as outcomes, respectively.

3.2. Relations between study variables

Table 1 presents the sample means for, and zero-order correlations between, the variables. Given the non-normal distribution of the habit and drinking outcome variables, correlations are presented for descriptive purposes only. Each of the IATs was normally distributed but, as noted above, the drinking outcomes were better modeled as a ZINB distribution (Fig. 1, panels 1–3). Fig. 1 (panel 4) presents a histogram of the habitualness variable prior to dichotomization.

3.3. Evaluating implicit alcohol associations and habit as predictors of drinking

3.3.1. Drinking identity IAT and habitualness

Results in Table 2 reveal a consistent pattern. For each of the outcomes (drinks per week, RAPI, and AUDIT scores), step 1 results revealed significant negative associations between the drinking identity IAT and likelihood of no consumption, no problems, and zero AUDIT scores (logistic/zero-inflated portions) and significant positive associations between the drinking identity IAT and amount of alcohol consumed, drinking problems, and AUDIT scores (count portions). Thus, as expected, a stronger drinking identity was associated with greater drinking, problems, and risk of alcohol use disorders. Results at step 2 revealed that habitualness accounted for unique variance in all outcomes in both logistic and count portions of models. As expected, habitualness was associated with a lower likelihood of no consumption, no problems, and zero AUDIT scores (logistic/zero-inflated portions) and was positively associated with consumption, problems, and AUDIT scores for the count portion. Contrary to expectations, step 3 revealed no interactions between the drinking identity IAT and habitualness for any of the outcomes in either the logistic or count portion of the models.

3.3.2. Alcohol approach IAT and habitualness

The pattern of results for models examining the alcohol approach IAT and habitualness (Table 3) was identical to the results for those

[1] Because the drinking outcomes were not normally distributed, we compared the fit of several models: Poisson and Negative Binomial models as well as zero-inflated versions of those models (Hilbe, 2011). In all cases, statistical tests of dispersion and Vuong's test identified the Zero-inflated Negative Binomial (ZINB) models as exhibiting significantly better fit than the Poisson, Negative Binomial, or Zero-inflated Poisson Models. We also considered the use of ZINB versus Hurdle Negative Binomial models. These models are not nested but one can compare them via their fit indices. Their fit indices were nearly identical. Given the similarity in fit, we then considered the assumptions underlying ZINB and hurdle models. Hurdle models assume that all zero values in a distribution come from a qualitatively separate category (e.g., complete abstainers), whereas ZINB models assume that zero values come from two sources, one that is qualitatively different (e.g., complete abstainers) and one that is part of the negative binomial distribution (e.g., people who are not complete abstainers but simply did not drink in the previous time period or who didn't happen to have any alcohol-related problems, but theoretically could have). ZINB models seem to be a better theoretical fit for the present data as the study included drinkers and non-drinkers (including some participants who reported no lifetime alcohol use).

Table 1
Means and correlations among study variables.

	Gender	Habitualness	Identity IAT	Approach IAT	Excite IAT	Drinks per week	RAPI score	AUDIT score
Gender	–							
Habitualness	−0.03	–						
Identity IAT	−0.11*	0.36***	–					
Approach IAT	−0.12**	0.33***	0.22***	–				
Excite IAT	−0.11*	0.18***	0.14**	0.39***	–			
Drinks per week	0.00	0.46***	0.37***	0.20***	0.16***	–		
RAPI score	0.03	0.41***	0.28***	0.15**	0.09	0.62***	–	
AUDIT score	0.02	0.58***	0.43***	0.28***	0.20***	0.80***	0.73***	–
Mean	0.58	0.47	−0.08	−0.21	−0.11	5.15	2.95	4.35
SD	0.49	0.50	0.45	0.40	0.46	8.61	6.01	5.05

Note. $N = 494$. Gender was coded 0 = men, women = 1. Habitualness was coded none = 0, any = 1. Identity IAT = drinking identity IAT score where higher values equal stronger associations with drinker and me (vs. non-drinker and me). Approach IAT = alcohol approach IAT score where higher values equal stronger associations with approach and alcohol (vs. avoid and alcohol). Excite IAT = alcohol excite IAT where higher values equal stronger associations with excite and alcohol (vs. depress and alcohol). RAPI = score on the Rutgers Alcohol Problem Index. AUDIT = score on the Alcohol Use Disorder Identification Test. IAT = Implicit Association Test.
*** $p < .001$.
** $p < .01$.
* $p < .05$.

examining drinking identity IAT and habitualness, with two exceptions at step 1. Contrary to expectations, the alcohol approach IAT was not significantly associated with number (i.e., counts) of drinks per week or number of alcohol-related problems. Step 2 results, consistent with hypotheses and the drinking identity IAT findings, revealed a significant unique variance accounted for by habitualness for all outcomes in both logistic and count portions of models. Contrary to expectations, in step 3, there were again no significant interactions for logistic or count portions of the models.

3.3.3. Alcohol excite IAT and habitualness

Results for the logistic portions of the models examining the alcohol excite IAT and habitualness (Table 4) were similar to those found for drinking identity and alcohol approach IAT. When examining likelihood

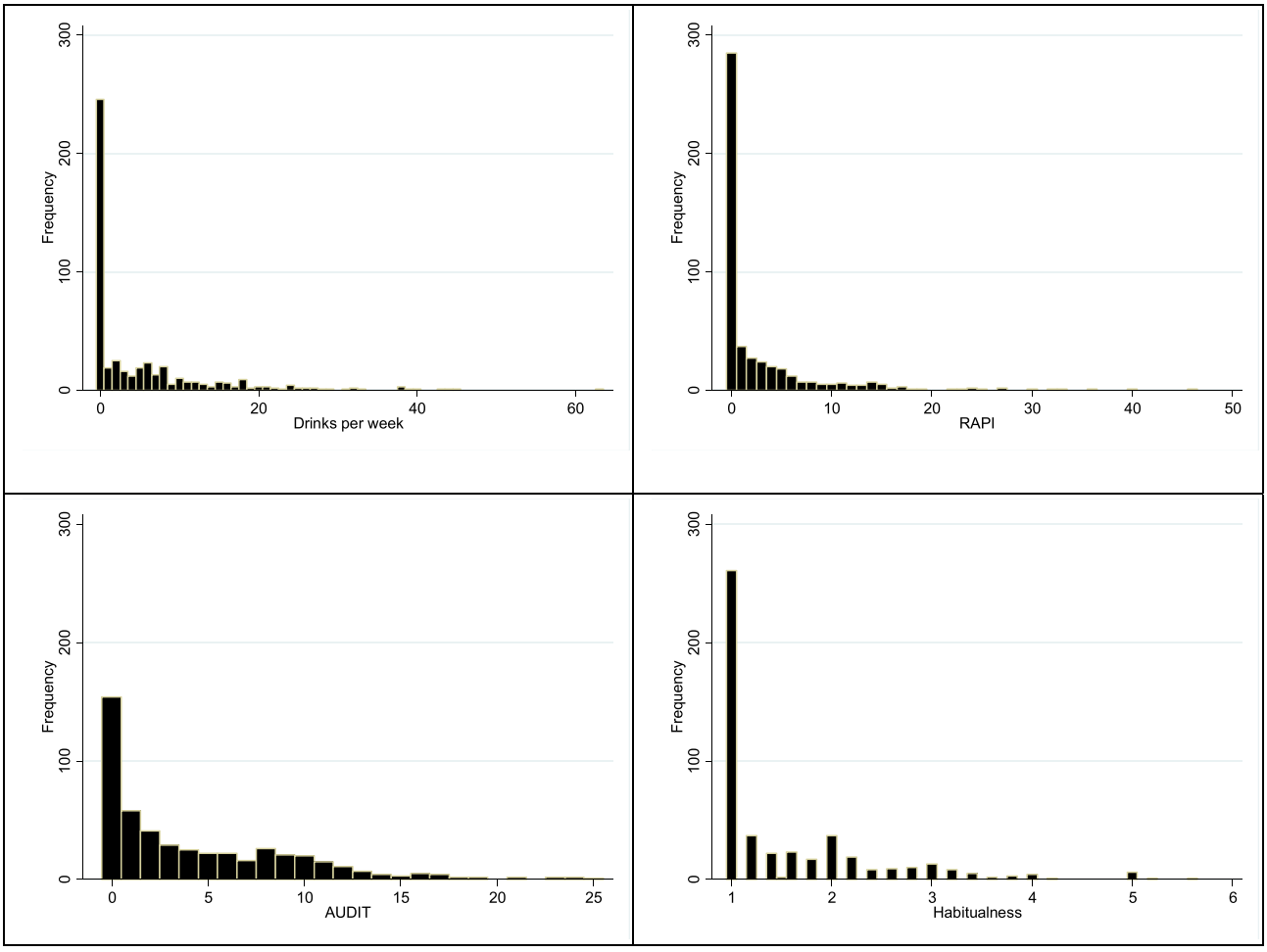

Fig. 1. Distribution of responses for drinking outcomes and habitualness. N = 506. RAPI = score on the Rutgers Alcohol Problem Index. AUDIT = score on the Alcohol Use Disorder Identification Test.

Table 2
ZINB model of drinking outcomes as a function of drinking identity IAT and habitualness.

	Logistic portion of model			Count portion of model		
	B	*SE B*	*Z*	*B*	*SE B*	*Z*
DV = drinks per week						
Gender	−.41	.23	−1.79	−.13	.13	−1.03
Drinking identity IAT	−1.76	.28	−6.35***	.77	.15	4.98***
Habitualness	−2.42	.29	−8.48***	.60	.15	3.98***
IAT * habitualness	−1.00	.70	−1.42	−.19	.35	−.53
DV = RAPI						
Gender	.09	.29	.30	.20	.19	1.09
Drinking identity IAT	−1.61	.38	−4.30***	.78	.23	3.43**
Habitualness	−2.96	.67	−4.40***	.80	.24	3.33**
IAT * habitualness	−1.91	1.57	−1.22	.03	.53	.05
DV = AUDIT						
Gender	−.62	.29	−2.18*	−.06	.10	−.58
Drinking identity IAT	−1.53	.34	−4.50***	.81	.12	7.06***
Habitualness	−3.76	.95	−3.95***	.74	.10	7.11***
IAT * habitualness	−1.55	1.88	−.83	−.07	.24	−.28

Note. Gender was coded 0 = men, women = 1. Habitualness was coded none = 0, any = 1. Drinking identity IAT = drinking identity IAT score where higher values equal stronger associations with drinker and me (vs. non-drinker and me). RAPI = score on the Rutgers Alcohol Problem Index. AUDIT = score on the Alcohol Use Disorder Identification Test. IAT = Implicit Association Test.
*** $p < .001$.
** $p < .01$.

Table 4
ZINB model of drinking outcomes as a function of alcohol excite IAT and habitualness.

	Logistic portion of model			Count portion of model		
	B	*SE B*	*Z*	*B*	*SE B*	*Z*
DV = drinks per week						
Gender	−.33	.22	−1.48	−.14	.14	−1.04
Excite IAT	−1.02	.25	−4.04***	.14	.15	.92
Habitualness	−2.54	.28	−9.01***	.79	.15	5.36***
IAT * habitualness	−.21	.60	−.35	−.94	.34	−2.74**
DV = RAPI						
Gender	−.03	.30	−.09	.13	.19	.67
Excite IAT	−1.25	.42	−2.97**	−.09	.22	−.42
Habitualness	−3.17	.68	−4.65***	.97	.23	4.30***
IAT * habitualness	−.03	1.12	−.03	−.21	.28	−.37
DV = AUDIT						
Gender	−.54	.30	−1.79†	−.05	.11	−.47
Excite IAT	−.97	.35	−2.80**	.32	.12	2.65**
Habitualness	−3.93	1.14	−3.44**	.89	.10	8.60***
IAT * habitualness	−1.01	1.57	−.64	−.59	.22	−2.64**

Note. Gender was coded 0 = men, women = 1. Habitualness was coded none = 0, any = 1. Alcohol excite IAT = alcohol excite IAT where higher values equal stronger associations with excite and alcohol (vs. depress and alcohol). IAT = Implicit Association Test. RAPI = score on the Rutgers Alcohol Problem Index. AUDIT = score on the Alcohol Use Disorder Identification Test.
*** $p < .001$.
** $p < .01$.
† $p < .10$.

of no consumption, no problems, and zero AUDIT scores, results revealed significant negative associations between the alcohol excite IAT and all three outcomes (step 1) and between habitualness and all three outcomes (step 2). In contrast, results for the count portions of the models varied by outcome. At step 1, the alcohol excite IAT was significantly and positively associated with AUDIT scores but not with drinks per week or drinking problems. At step 2, habitualness was again associated with significant unique positive associations with all three outcomes. At step 3, significant interactions between the alcohol excite IAT and habitualness were evident for drinks per week and AUDIT scores, but not for drinking problems.

The pattern of both significant interactions was similar but not in the predicted direction. Fig. 2 presents exponentiated predicted values from the count portion of the models. Among those who indicated some degree of habitualness in their drinking, the association between the excite IAT and drinking outcomes was not significant (drinks per week: $Z = -.14$, $p = .886$; AUDIT: $Z = .85$, $p = .393$), whereas among those who indicated no habitualness, there was a significant positive association between the excite IAT and both drinks per week ($Z = 2.99$, $p = .003$) and AUDIT scores ($Z = 3.67$, $p < .001$).[2]

Table 3
ZINB model of drinking outcomes as a function of alcohol approach IAT and habitualness.

	Logistic portion of model			Count portion of model		
	B	*SE B*	*Z*	*B*	*SE B*	*Z*
DV = drinks per week						
Gender	−.44	.23	−1.91†	−.16	.14	−1.17
Alcohol approach IAT	−1.87	.32	−5.89***	.08	.18	.66
Habitualness	−2.48	.29	−8.55***	.81	.15	5.26***
IAT * habitualness	−.40	.76	−.52	−.17	.35	.62
DV = RAPI						
Gender	−.05	.31	−.17	.08	.20	.43
Alcohol approach IAT	−2.17	.56	−3.90***	−.01	.25	−.03
Habitualness	−2.93	.58	−5.02***	1.11	.24	4.69***
IAT * habitualness	−.35	1.32	−.27	.17	.63	.27
DV = AUDIT						
Gender	.63	.29	−2.13*	−.12	.11	−1.13
Alcohol approach IAT	−1.90	.42	−4.48***	.43	.14	3.00**
Habitualness	−3.45	.72	−4.77***	.93	.11	8.87***
IAT * habitualness	−1.08	1.81	−.60	−.33	.26	−1.24

Note. Gender was coded 0 = men, women = 1. Habitualness was coded none = 0, any = 1. Alcohol approach IAT = alcohol approach IAT score where higher values equal stronger associations with approach and alcohol (vs. avoid and alcohol). RAPI = score on the Rutgers Alcohol Problem Index. AUDIT = score on the Alcohol Use Disorder Identification Test. IAT = Implicit Association Test.
*** $p < .001$.
** $p < .01$.
* $p < .05$.
† $p < .10$.

4. Discussion

We evaluated habitualness as a moderator of the relationship between implicit alcohol associations and drinking. Despite sound theory (e.g., Hofmann et al., 2008), significant moderation effects for habitualness were not observed with implicit drinking identity or implicit alcohol approach associations on any drinking outcomes. They were observed with implicit alcohol excite associations on two of the three drinking outcomes (e.g., consumption and risk of alcohol use disorder) but in the opposite direction than predicted — i.e., we observed a greater relationship between implicit alcohol excite associations at lower levels of (technically speaking, no level of) habitualness. Although not reported here, post-hoc analyses were conducted to test whether findings would hold if the sample was limited to those individuals who reported drinking alcohol: the overall pattern held.

Several factors could account for these unexpected findings. First, the current theory may simply be more applicable to more pronounced levels of habitual drinking (approximately 50% of the sample denied habitualness) — or may be more relevant to the maintenance of addiction versus the hazardous drinking more common in undergraduates. Second, it is also possible that assessing habitualness via self-report is

[2] We also examined associations using a different implicit task, the stimulus response compatibility (SRC: Field, Kiernan, Eastwood, & Child, 2008) task. Results were consistent with those found for the IATs presented herein. The SRC exhibited main effects in each model for the inflation and count portions, in the same direction as those reported for IATs. Habit was uniquely associated with the count and inflation portions of the model for drinks per week and with the count portion of the AUDIT score model. There was unrealistic estimate of the standard error for habitualness in the RAPI model (SE = 977, when all others were less than 1), thus we did not interpret step 2 or step 3 of this model. There were no interactions between SRC and habitualness in the inflation or count portion of the models for drinks per week or AUDIT scores.

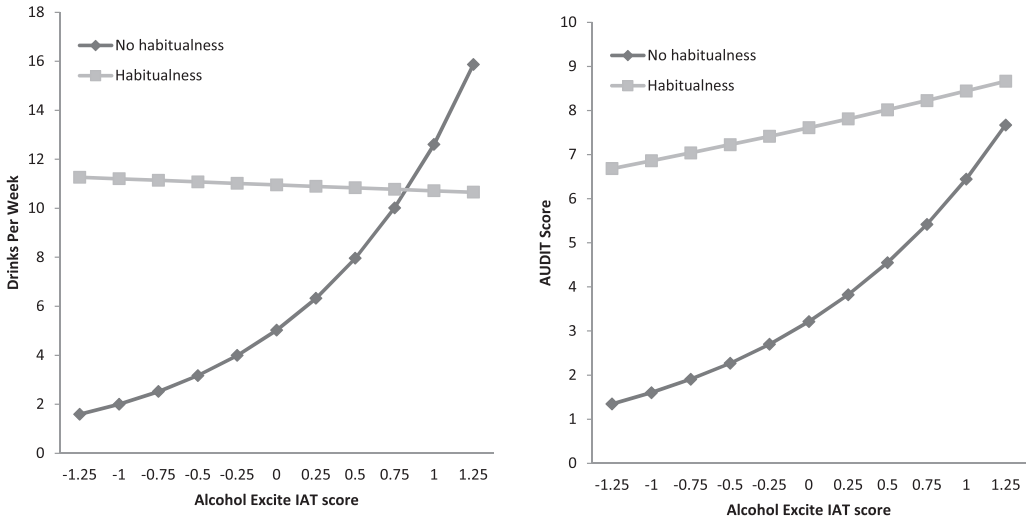

Fig. 2. Interactions between alcohol excite IAT and habitualness in predicting drinks per week and AUDIT scores. AUDIT = score on the Alcohol Use Disorder Identification Test. IAT = Implicit Association Test.

problematic. On the one hand, the endorsement of habitualness was low despite the fact that 27% of the sample had AUDIT scores of 8 or higher, 10% reported 10 or more alcohol-related problems, and 19% reported drinking at least 10 drinks a week. It is possible that many respondents were unaware, unable, and/or unwilling to report the extent to which their drinking is habitual. We note the inherent paradox of asking individuals to report about drinking automatically or without thinking. However, on the other hand, habitualness was the most robust predictor in this study. Finally, the unexpected moderation findings could reflect other underlying differences between drinkers. For example, some drinkers might nearly exclusively drink in exciting settings (e.g., parties, bars, and clubs) whereas other drinkers might drink in a wider range of settings, including those that are exciting as well as those that are not (e.g., parties, bars, and clubs but also alone, with a friend, or with one's parents). That first group would likely have stronger alcohol excite associations – that is more or less the only way they experience alcohol – and they might also be lower in habitualness because their drinking occurs in a more specific, limited context. The second group would likely have weaker alcohol excite associations – sometimes alcohol is associated with excitement but not always – and they might also be higher in habitualness because their drinking occurs in multiple settings and is more generalized. That could explain the unexpected moderation effects that alcohol-excite associations were more associated with consumption and risk of alcohol use disorders at lower habitualness. This reasoning is post-hoc, and unfortunately, not testable here.

Despite the largely null moderation findings, study findings do advance the field. First, habitualness was a consistent predictor of alcohol outcomes and that was true for both the zero-inflated (never vs. any drinking) and the count (gradations in drinking) portions of the models. Endorsing anything other no habitualness was associated with greater consumption, problems, and risk of alcohol use disorder, suggesting that even the slightest degree of drinking without thinking is risky. Second, our analytic approach yielded more knowledge about implicit alcohol associations. Like habitualness, implicit drinking identity consistently predicted unique variance in drinking outcomes for both parts of the models. In contrast, stronger implicit alcohol approach and alcohol excite association were consistently associated with the zero-inflation portion of the models but were only associated with the count model for AUDIT scores. Roughly speaking, this pattern implies that all three types of implicit associations can predict whether people ever versus never drink, and that implicit drinking identity associations are more sensitive to gradations in drinking.

Our findings have several interesting implications. One direction for future research is to examine these variables as risk factors longitudinally. In this cross-sectional study, implicit alcohol associations and habitualness were mostly independent predictors, but they could interact over time. The finding that habitualness was generally not a reliable moderator but that implicit alcohol associations were generally consistent predictors is also notable because it implies that even persons whose drinking is not habitual are likely vulnerable to the effects of implicit alcohol associations as a risk factor for hazardous drinking. Thus, it seems important to consider addressing both habitualness and implicit alcohol associations in treatment and/or prevention. For example, teaching mindfulness or other methods so that when drinking occurs, it is more effortful and intentional could be important tools for those whose drinking is habitual. Analogously, recent advances in cognitive bias modification suggest that it is possible to directly train implicit associations (see review in Wiers et al., 2013). Finally, given the robustness of the implicit drinking identity findings, developing strategies to strengthen alternative, and more adaptive, identities and/or weaken drinking identity may be useful.

4.1. Conclusion

We evaluated habitualness as a moderator of the relationship between implicit alcohol associations and drinking. Moderation was largely not supported with the exception of stronger relationships between implicit alcohol excite associations and alcohol consumption and risk of alcohol use disorders at lower (vs. higher) levels of habitualness. Findings continue to support implicit associations, especially implicit drinking identity, as unique predictors of drinking, and indicated that habitualness is a robust, unique predictor as well. Understanding how habitualness and implicit associations change, and possibly interact over time, will be exciting next steps.

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Contributors

Drs. Lindgren, Neighbors, Teachman, Kaysen, Norris, and Wiers designed the study. Dr. Lindgren outlined the manuscript, wrote the introduction, and edited all sections. Ms. Gasser oversaw data collection, and wrote the method. Dr. Neighbors conducted the analyses and wrote the results section. Drs. Wiers and Teachman wrote the discussion

section. Drs. Norris and Kaysen edited all sections. All authors have contributed to and approved the final manuscript.

Conflict of interest

All authors declare that they have no conflicts of interest.

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