Original Paper

Alcohol selectively impairs negative self-relevant associations in young drinkers

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Abstract

The stress-dampening effects of alcohol have been attributed to 'appraisal disruption'– decreased ability of stimuli to evoke threatening associations in memory. Appraisal disruption could apply to oneself as well as situational stimuli. This question was investigated in undergraduate drinkers ($n = 90$/Gender) with low or high anxiety sensitivity (AS; $n = 90$/AS Group), a trait linked with hyper-vigilance to threat. Subjects received alcohol (0.7 g/kg males; 0.63 g/kg females), placebo or soft drink and performed a speech about their appearance. Sequence of drink administration and speech advisory (threat) was manipulated between subjects: Threat before Drink, Threat after Drink, No-Threat Control. The Implicit Association Test measured self-relevant associations based upon time to classify positive and negative attribute words (e.g. Cute, Ugly) paired with self-relevant or non-self-relevant object words (e.g. Me, Them). Alcohol selectively slowed negative self-relevant decisions, regardless of other factors. Relative fluency of negative versus positive decisions (*D*) correlated inversely with state anxiety and systolic blood pressure immediately before speech performance, and correlated directly with severity of alcohol problems. These findings are consistent with the Appraisal Disruption hypothesis. Preferential impairment of negative self-relevant associations may decrease perceived vulnerability under alcohol and increase risk for alcohol problems in young drinkers.

Keywords

Alcohol, anxiety sensitivity, appraisal, conditioning, implicit, IAT, stress

Introduction

Alcohol is widely used to reduce anxiety and stress reactions in social situations. The stress-dampening effects of alcohol have been attributed to impairment of cognitive faculties that process threat stimuli (Curtin et al., 2001; Stritzke et al., 1996). The Attention Allocation hypothesis holds that alcohol restricts attention to salient stimuli, which reduces anxiety when proximal cues are benign, but not in the absence of such distraction (Steele and Josephs, 1990). The complementary Appraisal Disruption hypothesis asserts that alcohol impairs appraisal of a stimulus, so that events that would elicit unpleasant associations when sober lose their capacity to do so (Sayette, 1993). This latter effect is evident when alcohol is consumed before encountering threat stimuli, but may not emerge when alcohol is consumed after encountering the threat, at which point appraisal will have already occurred. Empirical evidence supports both models, and has emerged using both explicit (conscious, intentional) measures (e.g. self-report) and implicit (pre-conscious, unintentional) measures (e.g. Stroop task) of threat reactivity (Curtin et al., 1998; Sayette et al., 2001; Steele and Josephs, 1988).

The stress-dampening effects of alcohol may be especially valued by people with high social anxiety. Accordingly, alcohol leads to a greater reduction in Stroop interference to Social Threat words in high versus low socially anxious undergraduate students (Gerlach et al., 2006). Similar results have been found in male undergraduates with high anxiety sensitivity (AS), a trait linked with hyper-vigilance to threat, social evaluative concerns, and increased rates of problem drinking (Zack et al., 2007). In the latter study, alcohol also preferentially reduced anxiety and increased desire for alcohol in high-AS males who drank before encountering the threat.

Social anxiety has also been linked with biases on implicit measures of self-esteem: relative to subjects with low social anxiety, those with high social anxiety are slower to judge positive attributes as self-relevant on the Implicit Association Test (IAT) (Tanner et al., 2006). Both low and high socially anxious subjects perceived positive attributes to be more self-relevant than negative attributes, but the degree of positivity bias was stronger in the former group. Decreased positivity bias on the IAT following negative

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mood induction is also seen in formerly depressed patients but not in never-depressed controls, suggesting an association between positivity bias and trait vulnerability to negative affect (Gemar et al., 2001).

The primary aim of this study was to determine if alcohol augments the positivity bias on the IAT in young drinkers exposed to a psychosocial stressor. This would be reflected by an increase in relative response time to negative versus positive attribute words paired with self-relevant target words on the task. In view of the literature on Appraisal Disruption, a secondary aim was to see if alcohol's effect on the IAT was moderated by state (drink–threat sequence) and trait (AS, gender) factors. A final aim was to assess the predictive and concurrent validity of the IAT effect with respect to other correlates of alcohol stress-response dampening: involuntary attention to threat, state anxiety, physiological arousal, and problem drinking.

High and low-AS male and female undergraduates received alcohol before or after being advised they would be required to make a self-disclosing speech ('what I like and dislike about my body and physical appearance'). After the threat manipulation, subjects performed the Stroop task followed by the IAT. Placebo and Soft Drink conditions were included, along with a no-threat control, in a full factorial design. Mean effects for the Stroop and state anxiety are reported elsewhere (Zack et al., 2007). Mean effects and regression analyses for the IAT and physiological arousal (blood pressure) are reported here.

Methods and materials

Subjects

For this study, 180 university undergraduates (90/gender) with normal or corrected-to-normal vision were recruited from classes in Introductory Psychology. High-AS and low-AS subjects scored above and below the 70th and 30th percentile, respectively, for each gender on the Anxiety Sensitivity Index-Revised (ASI-R) (Peterson and Reiss, 1992) for all respondents in the class ($N = 1{,}464$). Cut-off scores were chosen to optimize statistical power by maximizing the difference between AS groups while ensuring a large group N. All subjects reported having consumed three or more drinks in one sitting in the 90 days before testing. They were randomly assigned to one of three drink conditions (Alcohol, Placebo, or Soft Drink), and one of three threat conditions (TBD: Threat before Drink; TAD: Threat after Drink; or C: No Threat – Control). Each Drink Condition × Threat Condition cell included an equal number of subjects from each gender and AS group. Detailed subject characteristics are reported elsewhere (Zack et al., 2007). Subjects received $60 compensation at study completion.

Materials/apparatus

The Beck Depression Inventory-short form (BDI-sf) (Beck and Beck, 1972) assessed depressive symptoms in the 2 weeks before testing. The Alcohol Use Disorders Identification Test (AUDIT) (Saunders et al., 1993) measured alcohol-related problems. The Personal Drinking Questionnaire (PDQ) (Vogel-Sprott, 1992) measured weekly alcohol use. A Drink Strength Rating Scale assessed perceived dose strength in terms of 355-mL (5%) bottles of beer (0–8) in Placebo and Alcohol subjects (Vogel-Sprott, 1992). The State portion of the State-Trait Anxiety Inventory (STAI) (Spielberger, 1983) assessed subjective anxiety during the test session. The Trait portion of the STAI measured typical levels of anxiety.

A J4-X ALERT (Alcohol Countermeasures Inc., Mississauga, Ontario, Canada) handheld breathalyzer measured blood alcohol concentration (BAC; %) at the start of the test session in all subjects, and at key intervals throughout the session for those who received alcohol. A mock breathalyzer, designed to closely resemble the ALERT, was used to strengthen the credibility of the placebo manipulation. The device registered a false BAC of 0.041%, the highest credible value (Martin et al., 1990), and was administered once, 10 min after placebo consumption ended.

A wrist cuff (HEM-601, Omron, Vernon Hills, IL, USA) measured blood pressure unobtrusively at key intervals during testing. Subjects were unable to see their readings precluding possible reactivity to this information. Female subjects, assigned to receive alcohol or placebo, were required to perform a pregnancy self-test before the start of the test session. They were advised of this requirement in the initial telephone contact before agreeing to participate.

Task description

The IAT was programmed in C: and administered on a PC. Subjects sat facing the screen at a distance of approximately 60 cm, and performed 224 classification trials to individual word targets. Task conditions are shown in Table 1. Three of five phases (at 16 trials) involved a simple classification. For Object trials (Phases 1 and 4), options were labeled 'Me' or 'Not-Me'; for Attribute trials (Phase 2) options were labeled 'Pleasant' or 'Unpleasant.' Labels appeared throughout each phase in the upper left- and right-hand corners of the screen, which corresponded to the 'z' and '/' response keys, respectively, on the keyboard. The label locations and designated response keys (left/right) were reversed for Phases 1 and 4. Items for the two levels of Object were **'Me':** *I Me Mine My Myself Self*; '**Not-Me':** *It Other Their Theirs Them They*. Items for the two levels of Attribute were **'Pleasant':** *Competent, Cute, Loved, Proud, Success, Valued, Smart,* and *Strong*; **'Unpleasant':** *Ashamed, Awkward, Failure, Hated, Stupid, Ugly, Useless,* and *Weak*. The words *Ashamed* and *Stupid* also appeared in the Social Threat condition of the Stroop task. However, repetition or categorical priming effects cannot account for IAT effects, which tap phase-specific associations when the same emotional words are paired with 'Me' versus 'Not-Me' Object terms. (The conditions in the Stroop were Physical Threat, Social Threat, Appearance-related, Alcohol, and Neutral.)

In each IAT phase except Phase 2, two randomly selected items from the 'Me' list and 'Not-Me' list were administered twice to ensure eight observations for all categories. Critical test trials occurred in Phases 3 and 5 (at 32 trials). These trials presented words from all four categories. In one of these Phases, 'Me' and 'Pleasant' words were assigned to the same response key, while 'Not-Me' and 'Unpleasant'

Table 1. Conditions for Versions 1 and 2 ($n = 90$/version) of the Implicit Association Test (IAT)

	Version 1		Version 2	
	Key mapping		Key mapping	
Phase	Left	Right	Left	Right
1	Me	Not-Me	Not-Me	Me
2	Pleasant	Unpleasant	Unpleasant	Pleasant
3	**Me-Pleasant**	**Not-Me-Unpleasant**	**Not-Me-Pleasant**	**Me-Unpleasant**
4	Not-Me	Me	Me	Not-Me
5	**Me-Unpleasant**	**Not-Me-Pleasant**	**Not-Me-Unpleasant**	**Me-Pleasant**

Phases 1–5 were administered twice in the same sequence to each subject. The difference in mean response time for Phases 3 and 5 on putatively incongruent trials (Me-Unpleasant/Not-Me-Pleasant) minus putatively congruent trials (Me-Pleasant/Not-Me-Unpleasant) defined the IAT effect.

words were assigned to the other response key. In the other Phase, the mappings were reversed, such that 'Me' and 'Unpleasant' words were mapped to the same response key, while 'Not-Me' and 'Pleasant' words were mapped to the other response key. Faster response time (RT) is expected when subjectively congruent (i.e. mnemonically associated) Object and Attribute items are mapped onto the same response key relative to when incongruent Object and Attribute items are mapped onto the same key. The difference in mean RT for incongruent minus congruent Phases defined the IAT effect.

Prior to performing the task under alcohol and before any threat manipulations, subjects learned the task with neutral stimuli (Metal-Non-metal/Hard-Soft) as described above. At the start of both the practice and experimental tasks, subjects saw a general instruction screen orienting them to the stimulus categories and response requirements. They were instructed to respond as quickly and carefully as they could to the word stimulus on every trial. Prior to each phase, a specific instruction screen appeared telling subjects the categories being tested in that phase and the key mapping for each category. Category labels were present throughout each phase to minimize confusion.

The sequence of events on each trial was identical. First, an orienting stimulus (four + signs arrayed in a square) appeared for 350 ms in the center of the screen to focus attention on the upcoming target. After a 125-ms blank screen, the target word was presented and remained on the screen until a key press response occurred. The execution of the response initiated the orienting stimulus for the next trial. Stimuli were presented in white 18-point font (1 cm in height) against a black background. Each word from a given category was presented in random order in the designated phases.

Each subject performed Phases 1–5 twice in the same sequence. As shown in Table 1, there were two test versions of the task. Version 1 administered Me-Pleasant (Not-Me-Unpleasant) trials in Phase 3 and Me-Unpleasant (Not-Me-Pleasant) trials in Phase 5; version 2 administered these conditions in reverse sequence. For each cell of the design (Gender × AS Group × Drink Condition × Threat Condition), half of the subjects were randomly assigned to Version 1 and half to Version 2. Counterbalancing version across subjects maximized the number of observations for each subject in critical Phases 3 and 5.

Procedure

The study was conducted in accord with the principles of the Helsinki Declaration (1989), and approved by the institution's Research Ethics Board. Eligible respondents were contacted by phone and invited to take part in a study on the behavioral effects of alcohol. In compliance with institutional ethics requirements, they were told that they may receive a low dose of alcohol (<2 standard drinks), a moderate dose of alcohol (2–4 standard drinks), or a soft drink, and that their drink condition would be determined randomly. They were advised that some subjects may be asked to make a brief speech, and that this would also be determined randomly. This was framed as an assessment of alcohol's effect on verbal function. Subjects did not know the speech topic beforehand. For purposes of the temporal manipulation (threat before vs. after drink), advisory of the speech topic ('what I like and dislike about my body and physical appearance') was the threatening stimulus. After the Stroop and IAT subjects performed the actual speech. Subjective and physiological responses were assessed before and after.

During the initial telephone contact, subjects were instructed to avoid alcohol for 24 h, caffeine for 4 h, and food for 3.5 h before the start of the test session, which occurred at noon. Figure 1 shows the sequence of events during the test session. Subjects read the consent form, which outlined study procedures, assured confidentiality, and confirmed formal ethics approval. After signing the consent form, they received their baseline breathalyzer assessment. Females in the Alcohol or Placebo conditions then received a pregnancy test (urine self-test). Baseline ratings of state anxiety (STAI) and blood pressure were also taken. Subjects then performed the practice version of the IAT (and Stroop). They were told that they would perform both tasks again after their drinks and that task requirements would remain the same.

Immediately after the baseline measures and practice IAT, subjects in the TBD and C conditions received their assigned experimental challenges. TBD subjects were told that, in a short time, they would be required to make a 3-min speech about their physical appearance (as described above). They were then escorted to a nearby room containing a video-camera mounted on a tripod and attached by cable to

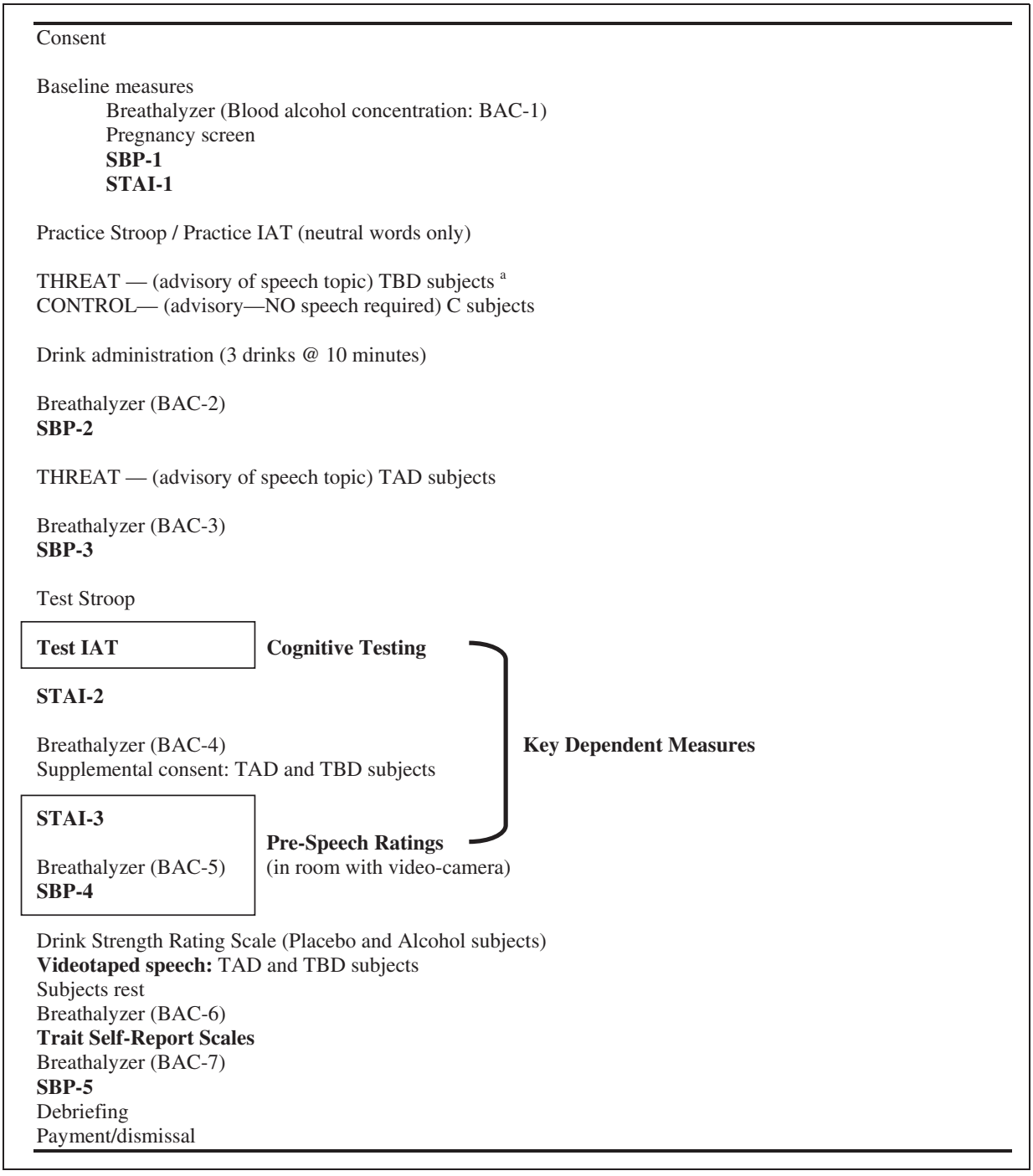

Figure 1. Timeline of events during test session

[a]SBP, systolic blood pressure (mm Hg); STAI, State-Trait Anxiety Inventory (state scale); TBD, Threat before Drink condition; C, Control condition; TAD, Threat after Drink condition.

a VCR. They were given a piece of paper and pen to write down any points they wished to include in their speech. After a 2-min interval, they were escorted back to the waiting room where they received their drinks.

At the same time that TBD subjects were advised of the speech topic, subjects in the C condition were advised that they had been assigned to a control condition and would not be required to make a speech. Instead, they were given a general interest article from *National Geographic* (November 2002, pp 124–126), which they were instructed to read in the waiting room next to the laboratory. Subjects in the TAD condition rested during this brief interval.

All subjects then received their assigned drinks, served in three equal-sized portions. Before drinking, they consumed a dry bagel plus 250 mL water to help standardize drink absorption. Subjects in the Alcohol condition received 0.7 g/kg (males) or 0.63 g/kg (females) of vodka, mixed in a ratio of 1:3.5 with non-caffeinated, carbonated soft drink (Mello Yello® Coca Cola Co., Atlanta, GA, USA). Placebo subjects received three 250-mL cups of chilled non-alcoholic beer (Molson Exel® Molson Coors Brewing Co., Toronto, Canada). The rim of each cup was misted with 50% alcohol solution to enhance olfactory cues for alcohol. Subjects in the Soft Drink condition received three 250-mL cups of Mello Yello. Drinks were served at 10-min intervals, and subjects were instructed to consume them steadily rather than all at once. BAC was assessed before and after drinking and at 20-min intervals thereafter.

Ten minutes after completion of drink 3, Placebo subjects received the mock breathalyzer test. Subjects in the TAD condition received the speech advisory 48 min after drinking commenced (28 min after receiving drink 3). Ten minutes later, all subjects performed the Stroop task (Zack et al., 2007). Two minutes after completing the Stroop, subjects performed the IAT, then provided their second state anxiety rating. The IAT was performed between 50–70 min after drinking began, which was designed to coincide with peak BAC.

After these measures, TAD and TBD subjects were escorted to the video-camera room where they received their pre-speech STAI, blood pressure and BAC measures, and Drink Strength Rating Scale (Alcohol and Placebo conditions); Group C subjects provided these ratings in the waiting room. After the speech, TAD and TBD subjects returned to the waiting room, where they received lunch. After lunch, they watched television or read magazines until their BAC had declined to 0.03%, at which point, they completed their trait scales. Prior to departure, subjects were debriefed and paid. All subjects received a pamphlet on safe use of alcohol and the contact number of the principal investigator in case of future questions about the study.

Data analytic plan

Subject background variables were assessed with 2 (Gender) × 3 (Drink Condition) analysis of variance (ANOVA). A 2 (Gender) × 2 (AS Group) × 3 (Stress Condition) × 2 (Drink Condition) ANOVA assessed drink strength ratings in the Alcohol and Placebo conditions. A $2 \times 2 \times 3 \times 7$ (Time) ANOVA assessed BAC in the Alcohol condition.

Task performance. The IAT effect was indexed by *D*, the difference in mean RT for Phases 3 versus 5 (Me-Unpleasant minus Me-Pleasant), divided by *SD* of RT for all trials combined in the two phases (Greenwald et al., 2003). An initial $2 \times 2 \times 3 \times 3 \times 2$ (Task Version) omnibus ANOVA identified significant main effects and interactions. A one-way ANOVA with planned comparisons assessed the effects of alcohol on *D* scores. The *D* score includes both error and non-error trials and does not reveal separate mean RT for Me-Unpleasant versus Me-Pleasant phases. Therefore, ANOVAs were conducted on mean RT and accuracy (% correct classification) with the same factors as described above and including Phase as a repeated measure. In line with standard practice for such analyses (Greenwald et al., 1998), mean RT was computed for correct responses and extreme trial scores (<200 ms; >3000 ms) were set to 200 ms (<1st percentile) and 3000 ms (>99th percentile), respectively. ANOVAs with planned comparisons investigated the specific effects of Drink Condition on RT and accuracy for positive and negative-self-relevant pairings on the IAT.

Physiological response to threat was assessed with a $2 \times 2 \times 3 \times 3 \times 4$ (Time: Baseline, Post-Drink/Speech Advisory, Post-IAT, Pre-Speech, Post-Speech) ANOVA of systolic blood pressure (SBP; mm Hg). Polynomial trend analysis probed significant within-subjects effects.

The relationship between IAT performance (*D*) and performance on the Stroop, state anxiety, SBP, and trait factors was assessed with two-stage hierarchical regression. Experimental factors (Gender, AS Group, Drink Condition, and Threat Condition) were entered in stage 1, and potential predictors in stage 2. At each stage, variables were removed by backward elimination, with a criterion for retention of $\alpha = 0.10$.

Results

Subject characteristics

Table 2 reports the mean (*SD*) scores on the five indices for each Gender and Drink Condition. ANOVAs yielded significant main effects of Gender on ASI-r (Bonferroni $p = 0.020$) and AUDIT (Bonferroni $p = 0.005$), and of AS Group on BDI-sf (Bonferroni $p < 0.001$). In line with published norms, scores on these scales were higher in females and high-AS subjects (Peterson and Reiss, 1992; Reinert and Allen, 2007). A Gender × Drink Condition interaction for age was the only other significant effect (Bonferroni $p = 0.025$), which arose because, in males, mean age was lowest in the Soft Drink and highest in the Placebo condition, whereas in females, this ranking was reversed. Mean AUDIT scores exceeded 8, the cut-off for hazardous drinking (Conigrave et al., 1995), in all drink conditions in males and in two of three drink conditions in females. PDQ scores for mean weekly alcohol consumption (quantity × frequency) corresponded to 6.3 standard drinks for a 70-kg male and 4.9 standard drinks for a 55-kg female. Thus, subjects were well

Table 2. Mean (*SD*) background characteristics for male and female subjects ($n = 90$/gender) in three drink conditions ($n = 60$/condition)

	Soft Drink		Placebo		Alcohol	
Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*
Males						
Age	21.7	2.5	23.0	2.6	22.2	2.7
ASI-r	23.0	12.3	21.9	12.4	24.0	12.4
BDI-sf	3.7	3.7	3.0	3.4	4.0	4.1
AUDIT*	9.8	4.9	8.8	4.6	10.6	4.7
Alcohol Use[a]	1.5	1.8	1.2	1.9	1.9	1.8
Females						
Age	22.6	3.3	20.8	1.8	21.0	2.0
ASI-r*	26.1	13.0	25.8	12.1	25.8	12.0
BDI-sf	2.7	3.6	4.3	4.6	4.5	5.8
AUDIT	5.8	3.1	8.1	4.7	8.4	5.1
Alcohol Use[a]	1.3	1.7	1.7	1.8	1.5	1.8

ASI-r, Score on Anxiety Sensitivity Index-Revised (Peterson and Reiss, 1992); BDI-sf, score on Beck Depression Inventory short form (Beck and Beck, 1972); AUDIT, Score on Alcohol Use Disorders Identification Test (Saunders et al., 1993). *$p < 0.05$, main effect of Gender for variable. [a]Alcohol Use: dose (mL/kg alcohol/occasion) × frequency (occasions/week) on Personal Drinking Questionnaire (PDQ) (Vogel-Sprott, 1992).

experienced with alcohol. BDI-sf scores were all well below 10, the cut-off for clinical depression (Furlanetto et al., 2005).

Drink strength ratings

The ANOVA of drink strength ratings yielded a main effect of Drink Condition, F (1, 65) = 31.07, $p < 0.0001$, and no other significant effects, p's > 0.30. Mean (*SD*) ratings were 3.7 (1.4) and 2.1 (1.3) bottles of beer for Alcohol and Placebo conditions, respectively. Ratings for Placebo also significantly exceeded 0, t (65) = 12.50, $p < 0.0001$. Thus, Alcohol subjects accurately gauged their dose and Placebo subjects found the manipulation to be credible.

Blood alcohol concentration (BAC)

The ANOVA of BAC scores yielded a significant main effect of Time, F (6, 114) = 203.91, $p < 0.0001$, and no other significant effects, p's > 0.07. Mean (*SD*) BAC was 0.063% (0.015) just before the IAT (peak value: 0.064%), 0.060% (0.013) immediately after the IAT, and 0.060% (0.011) just prior to the speech. Thus, IAT scores were obtained near peak BAC.

Task performance

IAT effect. The ANOVA of *D* scores yielded no significant effects involving Version, p's > 0.08. Therefore, Version, which was counterbalanced across subjects in each experimental cell, was dropped from the analysis. The resulting ANOVA yielded marginal main effects of AS Group, F (1, 137) = 3.56, $p = 0.061$, and Drink Condition, F (2, 137) = 2.88, $p = 0.060$. Low-AS subjects displayed larger mean (*SD*) *D* scores, 0.81 (0.38) than high-AS subjects did, 0.70 (0.38).

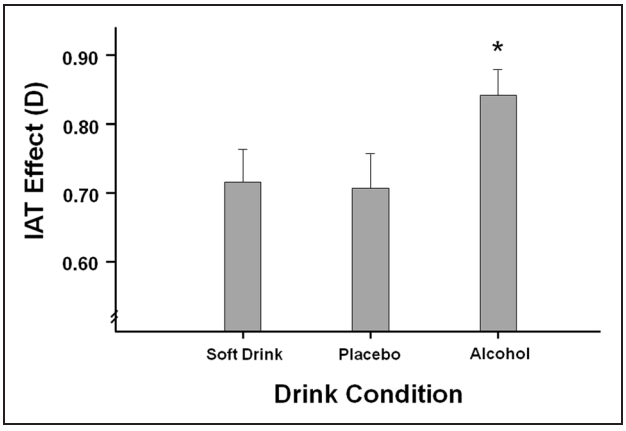

Figure 2. IAT effect in three drink conditions ($n = 60$/condition), as indexed by *D*, the difference in mean response time (RT) on Me-Unpleasant minus Me-Pleasant trials divided by the standard deviation in RT for all trials combined.

Figure 2 shows the mean (*SE*) *D* scores for the three drink conditions. The one-way ANOVA with planned comparisons yielded a significant pair-wise difference for alcohol versus placebo, t (170) = 2.17, $p = 0.032$, and alcohol versus soft drink, t (170) = 2.07, $p = 0.040$, and no difference between placebo and soft drink, $p > 0.89$ (planned comparisons are permissible in the absence of a significant overall F statistic, see Howell, 1992). Thus, the relative effect size for RT on Me-Unpleasant versus Me-Pleasant trials (i.e. positivity bias) was significantly greater under alcohol than soft drink or placebo, and the expectation of alcohol had no effect.

Mean RT. An initial omnibus ANOVA of mean RT scores yielded no main effect of Version or Version × Phase interactions, p's > 0.12. Therefore, Version was dropped from the analysis. The resulting ANOVA yielded a significant Phase × Drink Condition interaction, F (2, 139) = 3.15, $p = 0.046$, a marginal Phase × Gender interaction, F (1, 139) = 3.47, $p = 0.065$, and no other significant or marginal Phase-related effects, p's > 0.10.

Figure 3 shows the mean (*SE*) RT for each Drink Condition in the 'Me-Pleasant' and 'Me-Unpleasant' phases. Comparison of the left and right *y*-axis scales for the two phases confirms that mean RT was much faster (more than 352 ms) for Me-Pleasant than for Me-Unpleasant trials. Inspection of the left panel reveals that, across the three drink conditions, mean RT for Me-Pleasant trials differed by less than 13 ms, $p > 0.50$. Thus, neither alcohol nor placebo affected the fluency of positive self-relevant classifications. In contrast, inspection of the right panel shows that mean RT for Me-Unpleasant trials differed substantially across the drink conditions. The follow-up ANOVA with planned comparisons found that mean RT for the Alcohol condition was significantly greater than for the Soft Drink condition, t (139) = 3.38, $p < 0.001$, as well as the Placebo condition, t (139) = 4.97, $p < 0.001$. There was no difference in mean RT in the Soft Drink versus Placebo conditions, $p > 0.10$. Thus,

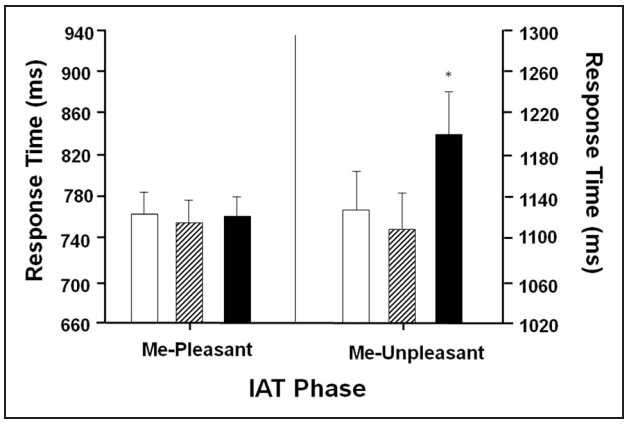

Figure 3. Mean response time (RT) in three drink conditions ($n = 60$/condition) on Me-Pleasant trials and Me-Unpleasant trials on the Implicit Association Test (IAT). Clear Bars = Soft Drink; Hatched Bars = Placebo; Filled Bars = Alcohol. Vertical bars show standard errors of the mean.

alcohol selectively slowed negative self-relevant classifications, and there was no significant expectancy effect.

The marginal Phase × Gender effect emerged because mean RT on Me-Pleasant trials was 68 ms slower in males than females, whereas mean RT on Me-Unpleasant trials was 124 ms slower in males than females. Thus, compared with females, RT in males was preferentially slower on trials that involved negative self-relevant classifications.

Response accuracy. The ANOVA of accuracy scores (%) yielded a significant main effect of Phase, $F(1, 10) = 119.84$, $p < 0.0001$, a significant Phase × Drink Condition × Version interaction, $F(2, 101) = 3.97$, $p = 0.022$, and no other significant effects, p's > 0.09. Table 3 reports the mean (*SD*) accuracy scores for each level of the interactive factors, and shows that the Phase effect denoted consistently greater accuracy for 'Me-Pleasant' versus 'Me-Unpleasant' trials. The interaction arose because the Phase effect was smallest for the Soft Drink condition on Version 1, but largest for Soft Drink condition on Version 2. Thus, in subjects who neither expected nor received alcohol, encountering Me-Unpleasant trials first (Phase 3, Version 2) maximized errors on those trials, whereas encountering Me-Pleasant trials first (Phase 3, Version 1) minimized errors when sober subjects later performed Me-Unpleasant trials (Phase 5, Version 1).

Physiological effects

The ANOVA of SBP yielded an AS Group × Drink Condition × Threat Condition × Time interaction, $F(16, 532) = 2.13$, $p = 0.007$, and no higher-order effects involving Drink Condition, p's > 0.11. The significant result involved an interaction of the linear trend for Time with other factors, $F(4, 133) = 4.43$, $p = 0.002$. Inspection of the means revealed that mean (*SE*) SBP decreased consistently over time from 120.8 (3.9) to 108.2 (4.1) mm Hg in Low-AS subjects who received placebo and no stressor. SBP increased consistently over time from 117.3 (3.7) to 127.1 (3.9) mm Hg in Low-AS subjects who received speech notification before drinking (TAD) placebo and from 112.5 (3.9) to 119.1 (4.1) mm Hg in those who received soft drink. In contrast, SBP decreased consistently over time from 117.2 (3.7) to 110.6 (3.9) mm Hg in Low-AS subjects who received speech notification before alcohol (TBD). A step-wise decline in SBP from 121.3 (3.7) to 116.2 (3.9) mm Hg was evident in Low-AS subjects who received speech notification after drinking alcohol. High-AS subjects who received no stressor displayed a downward overall trend in SBP across time from 117.6 (4.2) mm Hg to 91.5 (4.4) mm Hg under alcohol but no reliable trend under placebo or soft drink. Thus, in the active stress conditions, alcohol only reduced SBP in Low-AS subjects who received the threatening speech advisory before drinking.

Table 3. Mean (*SD*) classification accuracy (%) for 'Me-Pleasant' and 'Me-Unpleasant' phases for three drink conditions ($n = 60$/condition) in two versions of the Implicit Association Test (IAT; $n = 90$/version), Version 1 (Me-Pleasant = Phase 3; Me-Unpleasant = Phase 5), Version 2 (Me-Unpleasant = Phase 3; Me-Pleasant = Phase 5)

	Soft Drink		Placebo		Alcohol	
	M	*SD*	*M*	*SD*	*M*	*SD*
Version 1						
Me-Pleasant	96.5	3.8	94.0	4.4	95.7	4.4
Me-Unpleasant	89.9	13.7	83.2	14.8	82.5	14.3
Version 2						
Me-Pleasant	96.2	4.4	97.1	4.4	97.0	3.8
Me-Unpleasant	80.7	14.3	90.2	14.8	85.4	13.7

Predictors of IAT performance (D)

Table 4 reports multiple R, β and p values for the final models generated by the regression analyses of Stroop RT, STAI-State scores, SBP, and trait factors.

Stroop. The analysis of Stroop RT scores yielded a marginal effect of Drink Condition, $p = 0.087$, and no significant effects, $p > 0.10$. Thus, involuntary attention to Physical Threat, Social Threat, Appearance-related, Alcohol or Neutral word cues was not reliably related to self-relevant associations on the IAT.

STAI-State. The analysis of STAI-State scores revealed significant effects of Drink Condition and Pre-Speech STAI, a marginal effect of Post-IAT STAI, $p = 0.088$, and no other significant effects, $p > 0.26$. The Drink Condition effect essentially recapitulated the ANOVA results: greater *D* score under alcohol than placebo or soft drink. The significant STAI effect indicated that a stronger positivity bias on the IAT was associated with lower state anxiety immediately before performing the speech.

Physiological reactivity. The analysis of SBP scores detected a significant effect of pre-speech SBP, a marginal

Table 4. Final models for regression analyses of the relationship between IAT performance (*D*) and performance on the Stroop task (time to color-name Social Threat, Physical Threat, Appearance-related, Alcohol and Neutral words), state anxiety (STAI-state at baseline, post-Stroop/IAT, pre-speech), physiological reactivity (systolic blood pressure (SBP; mm Hg) at baseline, post-drinks, post-Stroop/IAT, pre-speech), and trait factors (Age, BDI-sf, STAI-trait, AUDIT, average alcohol dose [mL/kg] per drinking occasion, weekly frequency of drinking) in university undergraduates ($n = 90$/gender). Experimental factors (Gender, AS Group, Drink Condition, Threat Condition) were entered in stage 1; potential predictors in stage 2. The constant was significant in all analyses, $p < 0.001$

Predictor	*R*	*F*	*p (F)*	*β*	*t*	*p (t)*
Stroop	0.131	2.96	0.087			
Drink Condition				0.131	1.72	0.087
STAI-State	0.243	3.37	0.020			
Drink Condition				0.178	2.28	0.024
Post-Stroop/IAT				0.281	1.72	0.088
Pre-Speech				−0.388	−2.38	0.018
SBP	0.423	3.62	0.029			
Post-Drinks				0.153	1.73	0.085
Pre-Speech				−0.233	−2.65	0.009
Trait Factors	0.199	3.12	0.047			
STAI-Trait				−0.157	−1.91	0.058
AUDIT				0.167	2.04	0.044

IAT, Implicit Association Test; AS Group, Anxiety Sensitivity (Low/High); Drink Condition (Soft Drink, Placebo, Alcohol), Threat Condition (threat before drink, threat after drink, no threat control); STAI, State-Trait Anxiety Inventory; AUDIT, Alcohol Use Disorders Identification Test.

effect of Post-speech advisory SBP, $p = 0.085$, and no other significant effects, $p > 0.15$. A stronger positivity bias on the IAT was associated with lower physiological arousal immediately before performing the speech.

Trait factors. The analysis of scores for the Trait Factors detected a significant effect of AUDIT score, a marginal effect of STAI-Trait, $p = 0.058$, and no other significant effects, $p > 0.17$. Thus, a stronger positivity bias was associated with more severe drinking problems.

Discussion

This study investigated the acute effects of alcohol on implicit positive and negative self-relevant associations in young drinkers. The moderating effects of gender, personality and timing of alcohol consumption with respect to threat (advisory of a self-disclosing speech) were also examined. The relationship between self-relevant associations and established state (e.g. anxiety, SBP) and trait (e.g. problem drinking) correlates of alcohol stress-response dampening was assessed with regression.

We previously reported that high-AS males who consumed alcohol before speech advisory exhibited decreased Stroop interference to Social Threat words, decreased post-Stroop anxiety, and increased desire for alcohol (Zack et al., 2007). These effects were consistent with the Appraisal Disruption hypothesis, and suggested that alcohol use by high-AS males may relate to the preferential cognitive and subjective stress-dampening effects it confers to these individuals. The present results suggest that alcohol also has some general appraisal-related stress-dampening effects, not related to AS status or gender. Compared with soft drink or placebo, alcohol increased the positivity bias on the IAT regardless of other factors, and this result was due primarily to impairment of negative self-relevant decisions. The fluency of positive self-relevant decisions was virtually identical under alcohol, placebo, and soft drink. The generally higher error rates on negative-self-relevant decision trials under alcohol corroborated the RT data and indicated response conflict or perceived incongruity between negative attributes and oneself (cf. Rose and Duka, 2007; Seifert et al., 2006).

The analyses of SBP found that low-AS subjects displayed a consistent decline in physiological arousal over time under alcohol but not placebo or soft drink, when speech advisory preceded drink consumption; a similar though less consistent decline in SBP was evident in Low-AS subjects who received speech advisory after drinking. Thus, alcohol does appear to have an overall physiological stress-dampening effect in Low-AS subjects. In high-AS subjects, alcohol only decreased SBP when threat was absent. This latter result suggests that the cognitive and subjective stress-dampening effects of alcohol in high-AS males (Zack et al., 2007) do not derive from decreased sympathetic nervous system response to threat.

The regression analyses further suggest that the increased positivity bias – or negative dissociation – on the IAT under alcohol reflects the operation of a different process than that which mediated the selective effects of alcohol on Stroop and STAI in High-AS males. First, *D* was not significantly related to RT in any of the conditions on the Stroop. Thus, self-relevant affective associations appear to tap a separate construct than involuntary attention to threat cues. Second, *D* correlated with lower state anxiety immediately before the speech (i.e. in the room with the video-camera). In contrast, High-AS males who drank alcohol before speech advisory reported decreased anxiety after the cognitive tasks, but before moving to the room with the video-camera (Zack et al., 2007). Third, *D* also correlated with lower SBP immediately before the speech in front of the video-camera, suggesting that decreased subjective anxiety and decreased sympathetic arousal in a threatening context were separate manifestations of a common process. Lastly, *D* correlated with greater AUDIT scores. AUDIT scores were also higher overall in low-AS versus high-AS subjects. Thus, decreased negative self-relevant associations appear to be linked with more hazardous drinking behavior and decreased trait sensitivity to social evaluation.

The possibility that alcohol has partly dissociable cognitive, subjective, and physiological effects is consistent with its complex pharmacology. Graeff and colleagues noted that different threat paradigms engage different neurochemical systems (Graeff et al., 2003). Conditioned cues for threat engage GABA-ergic pathways and are strongly affected by benzodiazepine medications. In contrast, social evaluative situations, like that modeled by simulated by public speaking, engage a threat system that is sensitive to serotonergic manipulations. Graeff and colleagues suggest that alteration of this latter system may explain why serotonin-enhancing medications

are more effective in social phobia and panic disorder, both of which are characterized by high AS (Anderson and Hope, 2009; Scott et al., 2000). The serotonin 2a/c receptor antagonist, nefazodone, increases subjective anxiety before and during delivery of the speech in healthy volunteers (Silva et al., 2001). Nefazodone also decreases the dopamine-releasing effects of alcohol as well as absolute consumption and choice of alcohol versus water in alcohol-preferring rats (Olausson et al., 1998). This latter finding is noteworthy given that high-AS males who received alcohol before speech advisory also selectively reported increased desire for alcohol (Zack et al., 2007). Based on this pattern of results, we suggested that the stress-dampening effect of alcohol in high-AS males may be mediated by a serotonergic mechanism.

In contrast to the selective effects of alcohol in high-AS males, the pattern of effects in the present study suggests the operation of a more general process. In rats, both alcohol and benzodiazepines reliably reduce conditioned anxiety responses in the social defeat paradigm, where male 'intruders' are placed in the cage of a resident male (who is absent) that previously defeated them in a territorial fight (Tornatzky and Miczek, 1995). Alcohol and benzodiazepines also reduce conditioned avoidance of an aversive context involving physical threat (fall from a platform) in the elevated T-maze paradigm (Conde et al., 1999; Prunell et al., 1994). Decreased avoidance in the T-maze under sober conditions is also a feature of rats bred for high alcohol intake (Moller et al., 1997). In healthy volunteers, lorazepam reduces conditioned avoidance of threat in a human analogue of the T-maze (Perkins et al., 2009). Diazepam also blocks conditioned fear responses in healthy humans without altering responses to unconditioned aversive stimuli (Brignell and Curran, 2006), suggesting that 'emotional memories are disproportionately impaired by the benzodiazepines'.

The literature suggests that GABA-ergic mechanisms mediate conditioned responses to aversive cues and may contribute to the parallel effects of alcohol and benzodiazepines in paradigms that measure these responses. In the present study, the significant inverse correlation of *D* with pre-speech STAI-state and pre-speech SBP indicates that these measures tap a common construct. Disruption of appraisal – of oneself and one's situation – provides a parsimonious explanation for this linkage. Lower state anxiety and SBP in the presence of conditioned threat cues (room with a video-camera) is consistent with a GABA-ergic effect (Menezes and Fontes, 2007; Takenaka et al., 1995). The correlation between these subjective–physiological effects and increased *D* is also consistent with the dose-dependent impairment of contextual priming by diazepam in healthy volunteers (Shanks et al., 2006). Collectively, the evidence suggests that enhancement of GABA preferentially disturbs activation of learned emotional associations. If these effects are continuous rather than all-or-nothing, weak associations may be more susceptible to disruption than robust associations. The positivity bias on the self-relevant IAT appears to be universal (De Raedt et al., 2006), suggesting that negative self-relevant associations are generally weaker than positive ones. This could explain the selective disturbance of negative associations by a moderate dose of alcohol in the present study.

The positive correlation between *D* and AUDIT scores indicates that individuals who are generally disinclined to negative self-evaluation are also more inclined to drink alcohol, despite its consequences (Clark et al., 1986). The main effect of alcohol on the IAT further suggests that drinking alcohol may temporarily induce this non-reflective profile in otherwise careful individuals. That is, by impairing negative self-relevant associations, alcohol may inure the drinker to feelings of doubt or apprehension that guide more cautious behavior (Zeichner et al., 1982). Whether positivity bias/negative dissociation causally affects reckless or intemperate behavior cannot be established from the present data. By including a risk-taking or passive avoidance task, future research could assess whether these processes mediate the relationship between self-relevant affective associations and alcohol-related consequences on the AUDIT.

Early reports of alcohol's effect on self-appraisal are consistent with the present IAT results. A study of the content of the self-disclosing speech in male undergraduates who received alcohol or placebo beforehand (Sayette, 1994), reported that 'Intoxicated subjects disclosed fewer negative items than sober subjects. In addition, intoxicated subjects were more likely to present negative attributes in a manner that was isolated from their self-concept than sober subjects. Alcohol did not affect disclosures of positive items. These results suggest that one negatively reinforcing effect of intoxication may be the strengthening of self-protective biases'. The present results provide a mechanism for this protective effect: impairment of negative self-relevant associations. The emergence of this effect on an implicit task suggests that the self-protective effects of alcohol are not due to experimental demand (e.g. bravado rather than anxiolysis). It also suggests that these effects may arise involuntarily. This may contribute to the incentive value of alcohol in situations where anxiety is difficult to consciously suppress.

The lack of moderating effect of Drink-Threat sequence on alcohol effects in this study appears to contradict a key tenet of the Appraisal Disruption hypothesis. One way to explain this apparent contradiction is to consider which element of the procedure was the 'threatening stimulus': advisory of the speech, or the physical context (i.e. conditioned stimulus; CS) of the speech? Sayette et al (2001) proposed that speech advisory was the threat, so that drinking before the advisory was critical to appraisal disruption, whereas drinking after speech advisory had relatively little stress-dampening effect because the threat had been encountered sober and thus already appraised. Their results and our results for high-AS males (Zack et al., 2007) are consistent with this assertion. However, the conditioned threatening properties of the speech context may become especially salient when one steps in front of the video-camera, particularly for subjects who do not typically think about social evaluation. In this case, the consistent increase in *D* under alcohol, and the inverse correlation between *D*, pre-speech anxiety and SBP, may have occurred because alcohol consumption always preceded the direct encounter with the video-camera (i.e. CS for threat). By this account, the present results do align with the predictions of the Appraisal Disruption hypothesis.

The present study had several limitations. First, the construct validity of *D* as a measure of implicit bias – i.e. whether it can reveal something veridical or more accurate about attitudes than can be obtained through self-report – has been questioned (Blanton and Jaccard, 2006). Second, the self-relevant IAT has been critiqued with respect to the critical role of the 'other' (i.e. Not-Me) pole of the Object dimension, which may be construed as inherently negative rather than neutral (Karpinski, 2004). Third, the IAT engages lower-order (non-semantic) cognitive processes such as task-set switching (Klauer and Mierke, 2005). Disturbance of these basic executive processes could conceivably account for the effects of alcohol in the present study. None of these concerns can be ruled out. However, the regression analyses do mitigate them to some degree. The finding that *D* predicts the acute subjective and physiological state of the individual when confronted with a threatening context suggests that it is tapping a process that is relevant to stress-response dampening. In addition, the striking similarity between the selective impairment of negative self-relevant associations found here and selective absence of self-reported negative attributes described earlier (Sayette, 1994) suggests that *D* is not solely a measure of emotionally neutral stimulus–response incongruity or executive impairment, although these basic processes may contribute to it. Refinements to the IAT have been proposed that address some of these concerns (De Houwer and De Bruycker, 2007). Adoption of these techniques could help to address the limitations of the present study. Co-administration of tasks that tap executive function would enable higher-order semantic–conceptual effects to be isolated from the lower-order neuropsychological processes by means of co-variance. These are important considerations for future research.

Two additional limitations must be acknowledged. First, the sample included individuals from the high and low ends of the AS continuum. The cut-off for abnormal AS responses may be closer to the 90th percentile than the 70th percentile (Bernstein et al., 2010), which defined high AS in this study. Consequently, the present high-AS Group may have been heterogeneous, and this may have partially obscured the effects of AS Group. Future research should include three levels of AS, with high and low AS defined by 90th and 10th percentiles, respectively. Finally, the biological basis of alcohol's effects cannot be established from the present data. The role of serotonin versus GABA could be isolated by comparing the ability of nefazodone versus a GABA–benzodiazepine antagonist, such as flumazenil, to reverse various aspects of the alcohol effect.

Despite these limitations, this study has furnished novel information about the effects of alcohol on implicit self-relevant associations and their relationship to subjective–physiological responses to threat in young drinkers. The linkage of *D* and AUDIT scores suggests that investigating the pharmacological and neuropsychological mediators of these self-relevant cognitions could help to reduce hazardous aspects of alcohol use in this population.

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Conflict of interest

The authors declare no conflict of interest in the publication of this manuscript.

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