



## Short Communication

# Attentional bias to alcohol stimuli predicts elevated cue-induced craving in young adult social drinkers



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## HIGHLIGHTS

- Exposure to alcohol cues elicit cravings in non-dependent young adult social drinkers.
- Attentional bias toward alcohol stimuli predicts heightened cue-induced cravings.
- Cognitive processing of alcohol-related information may play a role in urges to drink.

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## ABSTRACT

Considerable evidence has identified biased cognitive processing of alcohol-related stimuli as an important factor in the maintenance of alcohol-seeking and relapse among individuals suffering from alcohol use-disorders (AUDs). In addition, a large body of research has demonstrated that exposure to alcohol cues can elicit powerful alcohol cravings. Little is known, however, about the possible relationship between attentional bias and cue-induced cravings, and even less is known about these processes in social drinkers without a personal history of AUDs. The goal of this study was to examine the possibility that attentional biases toward alcohol-related stimuli would predict elevated cue-induced alcohol craving in this population. Young adult social drinkers ( $N = 30$ , Mean age =  $22.8 \pm 1.9$ , 61% female) recruited from an urban university population completed a visual dot probe task in which they were presented with alcohol and neutral stimulus pictures that were immediately followed by a visual probe replacing one of the pictures. Attentional bias was measured by calculating reaction times to probes that replaced alcohol stimuli vs. neutral stimuli. Participants then completed a classic alcohol cue-exposure task and reported cravings immediately before and after alcohol and neutral cue-exposures. Not surprisingly, exposure to alcohol cues elicited significant cravings. Consistent with the study hypothesis, larger attentional biases toward alcohol stimuli predicted higher levels of alcohol craving. Findings demonstrate that heightened attention to alcohol stimuli can significantly impact motivation to consume in healthy young adults, and suggest a possible pathway linking cognitive processes early in the drinking trajectory to the later development of AUDs.

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## 1. Introduction

Attentional bias (AB) toward alcohol-related stimuli in the environment is thought to be an important factor in the development and maintenance of substance abuse (Field and Cox, 2008). The mechanisms underlying the association between AB and drinking, however, are not well understood. A possible explanation advanced in a review by Franken (2003) is that tonic levels of biased attention toward drug-related stimuli can give rise to increases in drug craving when a person

encounters drug-relevant stimuli, which in turn can potentiate phasic increases in biased attention toward drug-related stimuli, resulting in a 'vicious cycle' encouraging substance use.

In partial support of this mechanism, a recent meta-analysis found that AB and craving are significantly correlated, albeit modestly (Field, Munafò, & Franken, 2009). One limitation in the literature is that relations between AB and craving have been largely examined in dependent subjects [e.g., smokers, cocaine users (Marks, Alcorn, Stoops, & Rush, 2016)]. Less is known about the relations between AB and craving in non-dependent subjects, such as social drinkers, for whom AB may be an important marker for the risk of developing problem drinking. Relatedly, most studies have examined effects of craving responses to drug stimuli on acute, 'phasic' changes to AB. Although consistent with

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Franken's (2003) model, little research has investigated the first component of the model: possible relations between tonic levels of AB and cue-induced cravings.

To these points, one study of alcohol-dependent patients found that tonic levels of AB, assessed prior to a drug cue exposure, predicted higher levels of cue-induced craving (Garland, Franken, Sheetz, & Howard, 2012), but effects in non-alcohol dependent subjects were not investigated. Another study of non-dependent social drinkers found that cue-induced craving predicted acute, phasic increases in AB (Ramirez, Monti, & Colwill, 2015), but the effects of tonic levels of AB measured prior to cue exposures on craving were not examined. The goal of this study, therefore, was to examine the association between AB, assessed prior to a cue-exposure, and cue-induced cravings, in non-dependent social drinkers.

## 2. Material and methods

### 2.1. Participants

Young adult social drinkers ( $n = 30$ ) were recruited by advertisement from an urban university campus. Sixty percent of participants ( $n = 18$ ) were women and 40% ( $n = 12$ ) were men. The mean age of the sample was 22.6 years ( $SD = 1.6$ ). Forty-three percent of participants reported Caucasian ethnicity, 17% reported African American ethnicity, 17% reported Hispanic ethnicity, and 17% reported Asian ethnicity. In order to be eligible for the study, participants were required to be aged 18–25, with a typical drinking pattern of at least three alcoholic beverages per week. To reduce sources of heterogeneity in the sample, participants were excluded if they reported: 1) current alcohol dependence, 2) current other drug use (other than nicotine), or 3) a history of hospitalization for major mental illness. Finally, participants were excluded if they tested positive on a urine toxicology screen for illicit drug use.

### 2.2. Procedures

#### 2.2.1. Attentional bias

Attentional bias to alcohol cues was measured by a computerized alcohol dot probe task presented in Inquisit 4.0.8.0 (Millisecond Software, Seattle, WA) and modeled on the dot probe task described in Miller and Fillmore (2010). The image library included 10 simple images of alcoholic beverages ("alcohol" stimuli—e.g., beer, wine, liquor), 10 simple images of non-alcoholic beverages ("neutral" stimuli—e.g., soda, water, coffee) and 20 images of simple objects ("filler" stimuli—e.g., scissors, umbrella). Horizontally-paired images were presented in a practice block of ten trials and then an evaluative block of 80 trials, 40 alcohol-neutral pairs and 40 filler-filler pairs (to reduce habituation), presented in random order. During each trial, a fixation cross was presented in the center of the screen for 500 ms after which the paired images appeared for 1000 ms. After the images disappeared, a visual probe (an "X") appeared behind one of the images, and the participant had 1000 ms to identify whether the probe appeared behind the left-hand or right-hand image. Half of the alcohol-neutral pairs had the probe behind the alcohol image ("alcohol-congruent"), and the other half had the probe behind the neutral image ("alcohol-incongruent"). Reaction times were recorded for each correct probe response that occurred between 100 and 1000 ms after probe onset and average response times were calculated for probes that appeared behind alcohol images and neutral images (but not filler images). Attentional bias (AB) was quantified by subtracting the average alcohol-congruent probe response time from the average-incongruent probe response time, such that a positive difference indicated an attentional bias toward alcohol cues and a negative difference indicated an attentional bias away from alcohol cues.

#### 2.2.2. Cue-induced craving

Participants were then exposed to two in-vivo cues in counterbalanced order: 1) an alcohol cue, and 2) a neutral cue. For the alcohol cue, an experimenter poured the participant's preferred beverage into a glass and handed the glass to the participant, who was then instructed to hold the glass and periodically sniff the beverage, for a total of 90 s. The participant was instructed not to consume the beverage. For the neutral cue, an experimenter poured a glass of water in front of the participant, who then followed the same directions as during the alcohol cue exposure. Craving for alcohol was assessed by self-report immediately before and after each of the exposures. The cue-exposures were separated by a 90-second rest period, during which time participants viewed a nature video (Piferi, Kline, Younger, & Lawler, 2000).

### 2.3. Measures

#### 2.3.1. Background variables

Participants completed a questionnaire assessing basic demographic information, including age, gender, education, income, race/ethnicity, and past-year drinking habits (typical number of drinks/week, typical number of drinks/drinking episode, and maximum/drinking episode). In addition, participants completed the Obsessive-Compulsive Drinking Scale (OCDS) (Anton, Moak, & Latham, 1995). The OCDS measures general motivation and urge to drink, and served as a measure of problem drinking behavior. The OCDS has been shown to have excellent psychometric properties (Moak, Anton, & Latham, 1998), and was considered as a potential covariate in the study analyses.

#### 2.3.2. Alcohol craving

Participants completed a 5-item, 0–100 alcohol craving questionnaire immediately before and after each of the in-vivo exposures. This questionnaire has been used in our previous work [e.g., Erblich, Montgomery, and Bovbjerg (2009)] and evidenced excellent internal consistency (Cronbach's alpha ranged from 0.82–0.94) at all four administrations. The instrument is an improvement over the use of single-item craving assessments (Kozlowski, Mann, Wilkinson, & Poulos, 1989; Kozlowski & Wilkinson, 1987), and assessed craving using multiple descriptors, including "craving," "urge," "want," and "desire." Skewness for the craving outcomes in this sample ranged from  $-0.71$  to  $1.71$ . Kurtosis for the craving outcomes ranged from  $3.9$  to  $4.8$ . Although the distributions were somewhat leptokurtic, several common transformations did not remedy the kurtosis.

## 3. Results

### 3.1. Background measures

Participants reported beginning to drink regularly at age 19.0 ( $SD = 1.9$ , Skewness =  $-0.5$ , Kurtosis =  $-0.4$ ), consuming an average of 3.9 ( $SD = 2.0$ , Skewness =  $1.4$ , Kurtosis =  $1.7$ ) drinks per drinking episode, 2.8 ( $SD = 1.3$ , Skewness =  $1.1$ , Kurtosis =  $0.8$ ) drinking episodes per week, and a maximum drinks per episode of 11.0 ( $SD = 9.4$ , Skewness =  $3.2$ , Kurtosis =  $12.5$ ). Mean OCDS score in this non-alcohol-dependent sample of social drinkers was 10.4 ( $SD = 5.0$ , Skewness =  $0.7$ , Kurtosis =  $0.8$ ), well below the mean scores typically reported in clinical samples [e.g., 22.5 (Anton et al., 1995)]. Nevertheless, we found that 10 of the 30 participants reported  $\geq 5$  drinks per episode (males) or  $\geq 4$  drinks per episode, which is consistent with the NIAAA criteria for binge drinking. Binge drinking status was added as a covariate in the primary analyses.

### 3.2. Cue-induced alcohol craving

To confirm that alcohol cues elicited craving, we conducted Cue (Neutral, Alcohol)  $\times$  Time (Pre-stimulus, Post-stimulus) repeated

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