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# Attentional blink to alcohol cues in binge drinkers versus non-binge drinkers

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ABSTRACT

Previous studies have shown alcohol-related attentional biases in social drinkers; however, the temporal dynamics of these biases are not well understood. The current study examined this issue in 94 participants (27 male) categorized as binge drinkers (BD) or non-binge drinkers (NBD). Two versions of an alcohol-related attentional blink (AB) paradigm were used: one with words and one with images. It was predicted that BDs (versus NBDs) would exhibit reduced AB for alcohol cues, which would be enhanced for the pictorial version of the task (versus words). The relationships between AB and alcohol craving, quantity and frequency of alcohol consumption, symptoms of alcohol use disorder, and family history of alcohol use disorder (AUD) were also examined. While an AB was observed for both alcohol and non-alcohol targets in the NBD group, no AB was found for alcohol targets in the BD group. Furthermore, the magnitude of the AB was related to drinking, such that higher self-reported hazardous drinking was associated with smaller ABs to alcohol-related targets. However, AB was not related to craving or family history of AUD. These results suggest that alcohol-related stimuli are processed more efficiently by BDs, especially those with hazardous alcohol consumption patterns. These results may inform treatment and prevention efforts targeting binge drinkers.

## 1. Introduction

Binge drinking (BD) is a common, hazardous alcohol use pattern (defined in the U.S. as 4 drinks for women or 5 drinks for men over a 2-h period, enough alcohol to raise blood alcohol concentration to 0.08 within 2 h; Centers for Disease Control and Prevention, 2015; NIAAA, 2016), which is dangerous from both medical and psychosocial perspectives, with negative consequences ranging from increased aggression and hangover to more serious outcomes like alcohol poisoning, impaired driving, and legal problems (Jennison, 2004). Ultimately, a BD pattern increases risk for alcohol use disorder (AUD; Koob, 2013). Forty to 45% of college students and approximately 38% of non-college-attending adults aged 18 to 29 years reported binge drinking in the past year (Dawson, Grant, Stinson, and Chou, 2004; Wechsler et al., 2002). BD patterns have been associated with attentional biases and physiological reactivity to alcohol cues. Motivationally-relevant stimuli capture attention (e.g., for drinkers, a frosty mug of beer), causing a shift of attention toward these objects (Cisler, Bacon, and Williams, 2009; Ohman, 1993). Reactivity to alcohol cues may be present prior to the initiation of drinking, possibly related to cultural taboos or expectations around drinking, shaped by observation or popular media. These attentional biases may be a risk factor for the early initiation of drinking, increasing the likelihood of BD and/or AUD in adulthood (DiLeo, Wright, Mangone, and McDannald, 2015). This escalation may occur, in part, because with repeated use, attentional biases toward alcohol cues and cravings for alcohol increase as alcohol cues are imbued with incentive salience, a consequence of classical conditioning (Field and Cox, 2008; Field, Marhe, and Franken, 2014; Robinson and Berridge, 1993). Brain areas associated with the gating of binge drinking, such as the amygdala (Cui et al., 2013), tend to be reactive to addiction-related cues such as pictures of addictive substances (Goudriaan, de Ruiter, van den Brink, Oosterlaan, and Veltman, 2010), supporting the notion that attentional biases to alcohol cues may be involved in the escalation of casual use to a diagnosed disorder, though the precise mechanisms remain uncertain (Rinker et al., 2016; Wiers et al., 2015).

Dager et al. (2014) suggest that baseline reactivity to alcohol cues may be a better predictor of drinking and alcohol-related problems than either family history of AUD or trait impulsivity, adding to a growing body of literature showing attentional biases and cue-reactivity across

*Abbreviations:* AB, Attentional blink; AUDIT, Alcohol Use Disorder Identification Test (Babor, Higgins-Biddle, Saunders, and Monteiro, 2001); BD, Binge drinking; BDQ, Binge Drinking Questionnaire (Cranford, McCabe, and Boyd, 2006); BDs, Binge drinkers; DAQ, Desires for Alcohol Questionnaire (Love, James, and Willner, 1998); ERP, Event-related potentials; NBD, Non-binge drinking; NBDs, Non-binge drinkers; QFI, Alcohol Quantity/Frequency Index (Cahalan, Cisin, and Crossley, 1969); RSVP, Rapid serial visual presentation; T1, First target in an RSVP stream; T2, Second target in an RSVP stream

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the alcohol use continuum (Ceballos, Giuliano, Wicha, and Graham, 2012; Field et al., 2011; Petit, Kornreich, Dan, Verbanck, and Campanella, 2013; Petit, Kornreich, Dan, Verbanck, and Campanella, 2014; Petit et al., 2012; Wiers et al., 2015). Attentional biases to alcohol cues have also been shown to predict relapse in AUD, perhaps through craving-related mechanisms, and have been a target of therapeutic interventions, particularly efforts focused on attentional retraining (Field et al., 2014; Garland, Franken, and Howard, 2012; McGeary, Meadows, Amir, and Gibb, 2014; but see Christiansen, Schoenmakers, & Field, 2015).

Using paradigms such as Stroop, visual probe, spatial cueing, and flicker change blindness, attentional biases to alcohol cues have been demonstrated in participants with drinking histories ranging from light social drinkers to those with AUD, (Cox, Hogan, Kristian, and Race, 2002; Field, Mogg, Mann, Bennett, and Bradley, 2013; Garland et al., 2012; Hobson, Bruce, and Butler, 2013). Although these paradigms can demonstrate the existence of attentional biases toward alcohol cues, they tend to focus on the spatial dynamics rather than the temporal dynamics of attentional processing (Trippe, Hewig, Heydel, Hecht, and Miltner, 2007). Thus, they cannot determine whether attentional biases are due to increased efficiency of attentional processing at early levels of encoding or an inability to disengage attention from alcohol-related stimuli. The attentional blink (AB) paradigm could clarify the timing of attention to alcohol cues, providing a more nuanced account of attentional biases. One possibility is that alcohol-related associations may occur in the initial orienting stages of attention, reflecting more automatic cognitive processes (Wiers et al., 2007). Conversely, attentional biases may reflect a failure of cognitive control during later stages of processing (Wiers et al., 2007). Given the increased salience of alcohol cues in experienced drinkers (Field and Cox, 2008), it is likely that the temporal dynamics of alcohol-related processing may differ between social drinkers with and without a history of BD. A better understanding of the timing of attentional responses to alcohol cues could inform the selection of targeted interventions such as attentional retraining, cognitive behavioral therapy, and particularly, more recent time-sensitive approaches such as ecological momentary assessment (Mason, Mennis, Way, Lanza, Russell and Zaharakis, 2015).

In the AB paradigm, participants are presented with two targets interspersed between distracter stimuli in a rapid serial visual presentation (RSVP) stream. The first target (T1) is followed by a second target (T2), and the lag time between T1 and T2 varies. When T2 appears at lags of 100 to 500 ms, a deficit in T2 identification, the AB, is observed (Raymond, Shapiro, and Arnell, 1992). The mechanism underlying the AB is thought to involve pre-attentive detection of T1, with subsequent identification of T1 causing attentional resources to become temporarily diminished. This causes the attentional system to "blink", such that subsequent stimuli are not fully encoded until attention recovers, which with T2 identification at short lags (< 500 ms; Chun and Potter, 1995; Raymond et al., 1992). To our knowledge, only one study has used an AB paradigm to study attentional biases to alcohol cues. Tibboel, De Houwer, and Field (2010) used an AB paradigm with alcohol words versus soft-drink words in college drinkers. They found that heavy social drinkers had a reduced attentional blink when T2 was an alcohol word (versus a soft-drink word), suggesting an attentional bias for alcohol-related cues and more efficient processing of alcohol cues at early levels of encoding (Tibboel et al., 2010).

The current study extends the work of Tibboel et al. (2010) by examining alcohol-related AB in participants with a history of past 6-month binge drinking (binge drinkers, BDs) and social drinkers without a recent history of binge drinking (non-binge drinkers, NBDs) using two tasks: an image-based AB paradigm and a word-based version. It was predicted that BDs (versus NBDs) would exhibit more efficient processing of alcohol cues (versus control cues) and that this effect would be enhanced for the image-based AB task (versus the word-based version), as images were expected to have greater ecological validity than words. Relationships between the AB and hazardous drinking, craving for alcohol, and family history of AUD were also explored, as these factors have been recognized as risk factors for problem drinking, but have not been examined in the context of an AB task.

## 2. Method and materials

Procedures were approved by the Institutional Review Board at Texas State University and performed in accordance with ethical standards of the Declaration of Helsinki. All students provided written, informed consent prior to participation.

### 2.1. Participants

College students over the age of 18 with normal/corrected-to-normal vision were recruited from the Psychology Department at Texas State University and were compensated with extra course credit or $10/h. The only recruitment criterion was self-identification as a social drinker (an individual without AUD who tends to consume alcohol primarily in social settings and in moderate amounts; NIAAA, 1992). Participants were not pre-screened for BD history. Of the 142 participants who signed up for the study, 94 were ultimately included in data analyses. Participants were excluded because more in-depth questionnaire data revealed that their self-reported drinking histories failed to meet study criteria ($n$ = 43) or because T1 and/or T2 identification accuracy was < 60% ($n$ = 5).

The remaining 94 participants were grouped as historical binge drinkers (BD, $n$ = 47) or non-binge drinkers (NBD, $n$ = 47) based on drinking habits, including self-reported quantity and frequency index of alcohol use (QFI; Cahalan, Cisin and Crossley, 1969) and any BD episodes (NIAAA, 2016) in the past six months. The BD group reported QFIs > 0, and at least one BD episode (consuming 4–5 or more drinks, depending on gender, over a 2-h period; NIAAA, 2016) within the last 6 months. The NBD group reported QFIs > 0, and no BD episodes within the last 6 months. Recruitment for the two separate experiments (word-based versus image-based tasks) occurred at two separate time points; thus, there were natural variations in the demographic and alcohol use histories of the participants in the two experiments. The word-based version consisted of 55 participants (22 BD, 33 NBD) and the image-based version of the task consisted of 39 participants (25 BD, 14 NBD).

### 2.2. Stimuli

The word version of the task was based on Tibboel et al. (2010). Thirteen neutral distracter words were selected from a word list (Anderson, 2005). T1 targets consisted of kitchen gadgets ($n$ = 6) and office supplies ($n$ = 6). T2 targets consisted of alcohol-related ($n$ = 6) and soft-drink related words ($n$ = 6). Distracter words were presented in black 20-point Arial font, while targets were presented in green 20-point Arial font against a white background. The image task had identical structure and timing, but featured images from Ceballos et al. (2012), which did not have a one-to-one correspondence with the word task. Neutral distracters consisted of 13 nonsensical shapes (DeSchepper and Treisman, 1996), T1 stimuli consisted of images of kitchen gadgets ($n$ = 6, e.g., spatula, blender), and T2 targets consisted of office supplies ($n$ = 6, e.g., stapler, tape dispenser). T2 stimuli consisted of alcohol-related ($n$ = 6, e.g., mug of beer, whisky shot, glass of wine) and non-alcoholic images ($n$ = 6, e.g., soft drink can or bottle). Targets and distracter images were matched for contrast, color and luminance. To indicate their status as targets, T1 and T2 images were surrounded by a green border.

### 2.3. AB task

Participants completed one of two versions of the task (words or images), which involved viewing RSVP streams filled with distracter