



Full length article

Drinkers' memory bias for alcohol picture cues in explicit and implicit memory tasks



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ABSTRACT

Background: Alcohol cues can bias attention and elicit emotional reactions, especially in drinkers. Yet, little is known about how alcohol cues affect explicit and implicit memory processes, and how memory for alcohol cues is affected by acute alcohol intoxication.

Methods: Young adult participants ($N = 161$) were randomly assigned to alcohol, placebo, or control beverage conditions. Following beverage consumption, they were shown neutral, emotional and alcohol-related pictures cues. Participants then completed free recall and repetition priming tasks to test explicit and implicit memory, respectively, for picture cues. Average blood alcohol concentration for the alcohol group was 74 ± 13 mg/dl when memory testing began. Two mixed linear model analyses were conducted to examine the effects of beverage condition, picture cue type, and their interaction on explicit and implicit memory.

Results: Picture cue type and beverage condition each significantly affected explicit recall of picture cues, whereas only picture cue type significantly influenced repetition priming. Individuals in the alcohol condition recalled significantly fewer pictures than those in other conditions, regardless of cue type. Both free recall and repetition priming were greater for emotional and alcohol-related cues compared to neutral picture cues. No interaction effects were detected.

Conclusions: Young adult drinkers showed enhanced explicit and implicit memory processing of alcohol cues compared to emotionally neutral cues. This enhanced processing for alcohol cues was on par with that seen for positive emotional cues. Acute alcohol intoxication did not alter this preferential memory processing for alcohol cues over neutral cues.

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1. Introduction

Evidence from human and animal studies strongly suggests that emotional memories possess a “privileged status” compared to neutral memories (Cahill and McGaugh, 1995, 1996; Christianson, 1992; LaBar and Cabeza, 2006; Roozendaal, 2000). Preferentially retaining emotionally-laden events and cues (i.e., memory bias), particularly those with negatively charged valence, is likely linked to evolution and survival (Berntsen and Rubin, 2002; Hamann, 2001; Ohman and Mineka, 2001). In addition, individuals with post-traumatic stress disorder (Brewin, 2001; Ehlers and Clark, 2000), depression (Bradley and Lang, 1994; Watkins et al., 1992), and schizophrenia (Hamann, 2001; Herbener et al., 2007) display

more preferential memory for negative cues compared to healthy controls, suggesting that memory bias for emotional over neutral stimuli can be both adaptive and maladaptive, depending on context and extent.

Like emotional cues, alcohol cues are capable of biasing attention and eliciting emotional reactions (Townshend and Duka, 2001). They also may be remembered preferentially over neutral or non-appetitive cues (Franken et al., 2003b; Klein et al., 2013). The presence of a memory bias for alcohol over neutral cues would add to a growing alcohol cue exposure literature that has shown that exposure to alcohol cues in a laboratory setting can capture subjective craving (Carter and Tiffany, 1999; Franken et al., 2003a) and reward network brain activation patterns (Heinz et al., 2004; Kambouropoulos and Staiger, 2001; Myrick et al., 2004), and predict relapse rate (Grüsser et al., 2004; Niaura et al., 1988; Sinha and Li, 2007) and pharmacological treatment outcome (Myrick et al., 2008). Understanding cognitive processes that parallel subjective, neural, and behavioral responses could further shape intervention design.

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Table 1
Participant alcohol use characteristics.

	All participants (N = 161) M (SD)	Men (N = 84)	Women (N = 71)
Maximum drinks past 30 days ^a	7.7 (3.2)	9.1 (8.4)	6.3 (5.7)
Average weekly drinking occasions past 30 days ^a	1.8 (1.2)	2.1 (1.8)	1.5 (1.3)
Average standard drinks per occasion past 30 days ^a	5.0 (2.1)	5.9 (5.4)	4.2 (3.8)
Average weekly drinking occasions past year ^a	1.8 (1.1)	2.0 (1.8)	1.6 (1.4)
Average standard drinks per occasion past year ^a	5.1 (1.8)	5.7 (5.2)	4.5 (3.9)
Lifetime drinking duration (in years)	4.9 (2.0)	5.0 (4.5)	4.9 (4.4)
Average BMAST score	0.3 (0.9)	0.4 (0.2)	0.3 (0.1)

Note: BMAST = Brief Michigan Alcoholism Screening Test (4 points is suggestive of alcoholism; ≥ 5 points indicates alcoholism).

^a Significantly different between men and women, $p < .05$.

Another possible similarity between emotional and alcohol cues may be the potentiation of memory processes by state. Memory bias for emotional stimuli over neutral cues can be intensified by current, valence-parallel mood state (Fiedler and Stroehm, 1986), a process known as mood-congruent memory. For example, experimental induction of transient positive mood states facilitated better recall for positive cues (for review, see Lewis and Critchley, 2003) and individuals with major depressive disorder showed greater priming and recall of negative emotional cues compared to healthy control (Bradley et al., 1995; Watkins et al., 1992). In parallel to mood congruency, it could be argued that state congruency exists when an individual views alcohol cues during acute alcohol intoxication, such that memory for alcohol-related cues would be potentiated and memory bias for alcohol over neutral cues would be exaggerated during intoxication compared to a non-intoxicated state. The effect of alcohol consumption on state-dependent memory (i.e., retrieval of memory for stimuli learned under the same environmental condition) has been widely studied, but the role of alcohol consumption in state-congruent memory (i.e., when stimuli and state are parallel) has not been well delineated. Such alcohol-induced state-congruent memory intensification could contribute to escalations in trajectories of alcohol use behaviors.

This study examined explicit (i.e., free recall) and implicit (i.e., repetition priming) memory for picture cues that were either alcohol-related, emotionally positive, emotionally negative, or neutral. Explicit memory requires attention and conscious awareness, such as deliberate and effortful recall of past events. Implicit memory, on the other hand, refers to memory processes that proceed without conscious awareness and make few demands on attention or other cognitive resources (Dew and Cabeza, 2011; Schacter and Tulving, 1994; Schacter et al., 2007). Implicit memory processing is observable in experiments that do not include explicit instructions for memory performance, such as repetition priming, wherein reactions to previous viewed and new stimuli are compared while participants are instructed to engage in an unrelated task (i.e., sorting stimuli based on the presence or absence of image distortion). In this study, explicit and implicit memory processes were examined across groups of young adult drinkers without alcohol use disorders who either were given an active dose of alcohol (alcohol condition, target blood alcohol concentration of 0.08 mg/dl), an inactive dose of alcohol (placebo condition), or a beverage that contained no alcohol (control condition).

Our hypotheses were three-fold. First, we expected a memory bias for alcohol cues over neutral cues based on the expected parallels in salience between alcohol-related and emotional stimuli (Alkana and Parker, 1979; Bruce and Pihl, 1997; Knowles and Duka, 2004; Ray et al., 2012) and potential parallels between memory bias and attentional bias, which has been often found in drinkers (Field and Cox, 2008; Field et al., 2004). We specifically hypothesized greater explicit and implicit memory processing for alcohol cues compared to neutral cues in all beverage conditions. Second, we expected a disruption of explicit but not implicit memory process-

ing during alcohol intoxication in line with prior studies that have shown global impairment of recall (Birnbaum et al., 1978; Goodwin et al., 1969; Soderlund et al., 2005) but intact implicit memory processing (Fillmore et al., 1999; Hayes et al., 2012; Ray and Bates, 2006; Ray et al., 2004) for neutral and emotionally-valenced cues during acute intoxication. Third, we explored whether there was state congruent memory processing for the alcohol cues in the alcohol beverage condition by assessing beverage condition \times cue type interactions on explicit and implicit memory performance.

2. Material and methods

2.1. Participants

One-hundred sixty-one volunteers (84 women) between the ages of 21 and 24 ($M = 21.6$, $SD = 0.8$) were recruited through advertisements in university periodicals and bulletin boards as part of a larger study of family history, emotion, memory, and alcohol (Table 1). Participants reported their race as Asian (18%), Black or African American (11%), White (64%), or Other (8%); Hispanic origin ethnicity was reported by 19% of participants. Ninety-six percent were current college students. Exclusion criteria were a self-reported history of a childhood learning disability, special education, psychiatric or neurological disorder, treatment for a substance use disorder, and lifetime maternal substance use disorder (to rule out prenatal alcohol exposure effects), primary language other than English, medical conditions that interact with alcohol administration, current alcohol dependence, regular (weekly) illicit or prescription drug use, and, for women, planned or current pregnancy. Due to the drinking requirements of the study, also excluded were those who were 20% over- or under-weight (adjusted for gender, height, and body frame) based on the Metropolitan Life Height-Weight Table (1983) or reported drinking of less than four drinks (men) or three drinks (women) at least twice per month in the past year. Eligibility was ascertained initially during a telephone screening interview. At the beginning of the laboratory session, weight and pregnancy status were confirmed, and standardized self-report measures of alcohol and drug use and related problems were completed.

2.2. Procedure

Eligibility was initially ascertained during a telephone screening interview. Upon arrival at the laboratory, further eligibility information was obtained. This information included photo identification to verify age; breath alcohol concentration, oral temperature, and resting blood pressure to confirm the absence of alcohol, fever, and hypertension, respectively; weight and height measurements to verify self-reported values; and a urine pregnancy test to female participants to confirm a negative pregnancy status. In addition, participants completed a 30-minute battery that included standardized self-report measures of alcohol and drug use (heavy episodic drinking occasions, typical quantity, and frequency in the past 30 days) and related problems (Brief Michigan Alcohol Screening Test [B-MAST]; Chan et al., 1994). To be eligible, participants could not self-report alcohol or other drug use within the past 24 h or score 4 or greater on the B-MAST (i.e., present with greater than a low likelihood of alcohol dependence). As well, average alcohol quantity and frequency information needed to be consistent with that verbally reported in the telephone screening interview. All participants scheduled for a laboratory session were eligible according to these criteria and completed the study.

This study was approved by the Rutgers University Institutional Review Board for the Protection of Human Subjects Involved in Research and all participants provided written informed consent. All participants were asked to refrain from alcohol and other drug use (except caffeine and nicotine) for 24 h and eat a light meal no sooner than 3 h prior to arrival. Upon arrival at the laboratory, each participant was randomly assigned to complete two of the three beverage conditions in separate 3.5 h laboratory sessions. Data from the first session were used in this study in order to avoid learning effects. After completing the self-report battery, participants were seated in a comfortable chair in front of a TV screen in a sound-attenuated,

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