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## Liking, Craving, and Attentional Bias in Non-Dependent Drinkers

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Liking, Craving, and Attentional Bias in Non-Dependent Drinkers

A dissertation submitted in partial fulfillment  
of the requirements for the degree of  
Doctor of Philosophy in Psychology

by

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December 2017  
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## **Abstract**

The purpose of the present study was to better understand alcohol use problems by examining the effect of alcohol liking on alcohol attentional bias among non-dependent drinkers. An adapted model of Robinson and Berridge's (1993) incentive-sensitization theory of addiction was proposed which theorized that manipulation of alcohol liking would produce alcohol attentional bias (assessed via visual probe task) among non-dependent drinkers. To test this adapted model, alcohol liking was manipulated and the effect on alcohol attentional bias was examined. Participants were 53 legal-age, college drinkers ( $M_{age} = 23.49$ ; 32.1% female; 67.9% White Non-Hispanic). Participants completed measures of alcohol drink preference, eating attitudes, alcohol use behaviors, and inattention / hyperactivity symptoms. Liking for alcohol was manipulated using two beer tasting conditions in a repeated-measures design [cold beer ("like" condition) versus warm beer ("dislike" condition)]. Two cracker tasting conditions were also administered to obscure the true purpose of the study. Following manipulation of liking, participants completed alcohol liking and alcohol craving ratings as well as a visual probe task to assess alcohol attentional bias. Findings revealed effective manipulation of alcohol liking; however, contrary to the proposed hypotheses, alcohol attentional bias was not significantly correlated with either the warm or cold beer conditions. Also, there were no significant differences in the degree of alcohol attentional bias between warm and cold beer conditions. Follow up analyses showed that typical alcohol use behavior moderated the association between the liking rating and alcohol attentional bias following cold beer consumption; however, interpretation of the significant interaction was limited due to low statistical power to test moderation. Taken together, the current findings provide a unique examination of the effect of alcohol liking manipulation on alcohol attentional bias among non-dependent drinkers. Further

research investigating the relationship between manipulation of alcohol liking and alcohol attentional bias appears warranted given this initial examination.

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## **Dedication**

This dissertation is dedicated to my immediate family but especially my partner, Dr. Lauren Ashleigh Milner. It was the combination of my family and Lauren's enduring support that made this accomplishment a surreal reality.

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## Liking, Craving, and Attentional Bias in Non-Dependent Drinkers

High rates of alcohol use and misuse (e.g., social drinking, problematic drinking, and binge drinking) among young adults have been well documented in the literature (e.g., Ham & Hope, 2003; Karam, Kypri, & Salamoun, 2007). In a national survey, 62.9% of young adults reported that they were current drinkers (i.e., at least one drink in the past 30 days), 43.5% identified themselves as current binge drinkers (i.e., five or more drinks on the same occasion on at least 1 day in the past 30 days), and 16.0% identified themselves as current heavy drinkers (i.e., consumed five or more drinks on the same occasion on 5 or more days in the past 30 days; SAMHSA, 2013). In addition, previous research has consistently documented that traditionally-aged college students (aged 18-24) report higher levels of current alcohol use, binge drinking, and heavy alcohol use compared to similarly aged peers who are not enrolled in college (Dawson, Grant, Stinson, & Zhou, 2005; Hingson, 2010; Quinn & Fromme, 2011; Slutske, 2005). As such, college students are a particularly high-risk group for developing problematic patterns of alcohol use associated with a myriad of negative consequences, including unplanned and unsafe sexual activity, assaults, falls, injuries, criminal violations, and automobile crashes (Marczinski, Combs, & Fillmore, 2007).

Taken together, the high rates of alcohol use and alcohol-related negative consequences among college students suggest a need to better understand variables associated with the development of alcohol use disorders among this high-risk population. Previous research has largely focused on examining how individuals with physical or psychological dependence react (e.g., attend to, like, or crave alcohol) when presented with alcohol-related cues. However, diagnostic changes made in the DSM-5 (i.e., the addition of craving as a diagnostic criterion and the removal of legal problems as a criterion), has been suggested to greatly impact the way we

examine alcohol use disorders and its trajectory (CBHSQ, 2016). To date, considerably less research has examined responses to alcohol cues among non-physiologically or non-psychologically dependent populations. Given the wide range of negative consequences that can develop from problematic alcohol use, an understanding of how alcohol attentional bias (i.e., change of attention toward stimuli associated with the appetitive properties of alcohol) and alcohol liking (i.e., subjective feelings of pleasure to alcohol) are related among non-dependent drinkers may provide important information related to prevention and intervention services for alcohol use problems. Additionally, a greater understanding of non-dependent individuals' reactions to alcohol may yield helpful clinical implications aimed at predicting actual alcohol use behaviors as well as problems related to alcohol use.

### **Theoretical Models of Addiction**

To make sense of the role of attentional bias and craving in the development of alcohol-use disorders, considerations of both the explicit and implicit appraisals that motivate alcohol use are necessary. Early models examining reactivity to alcohol stimuli were hypothesized to be driven by the negative reinforcement properties of operant conditioning or by classical conditioning. Among negative reinforcement theories, the conditioned withdrawal model (Wikler, 1948), and the opponent process theory (Solomon & Corbit, 1977) have been the two most widely recognized and studied. The conditioned withdrawal model proposes the reason for continued alcohol use is the alleviation of withdrawal based symptoms that occur when alcohol use is continued following a period of discontinuation. Such withdrawal alleviation effects are believed to be the motivating factor that instigates cravings and urges for continued and sustained alcohol use. Additionally, opponent process theory posits that alcohol addiction is the result of the pairing of “a-processes” [e.g., brain reward circuits associated with hedonic pleasure

(i.e., affective actions and subjective pleasure) from alcohol consumption] and “b-processes” (e.g., opponent brain processes aimed at restoring homeostasis). In this theory, it is hypothesized that b-processes increase in magnitude and duration with repeated exposure to alcohol (e.g., tolerance) and are believed to inhibit and dampen a-processes (e.g., subjective pleasure), thus providing motivation to increase one’s quantity and frequency of alcohol use. However, when alcohol use declines, the conditioned homeostatic response is theorized to remain present which results in aversive withdrawal symptoms (Baker, Piper, McCarthy, Majeskiem & Fiore, 2004).

Alternatively, the conditioned compensatory responding model, based in classical conditioning, posits that environmental stimuli paired with alcohol use can become conditioned stimuli that elicit behavioral responses in the opposite direction to the direct effects of the substance being consumed. Such compensatory responses are hypothesized to increase craving for alcohol and interact with alcohol effects to produce a homeostatic reaction causing a reduction in experienced effects from alcohol (e.g., tolerance, Tiffany, 1990). While helpful for understanding how alcohol dependence may be impacted by the hedonic effects of alcohol consumption as well as how alcohol tolerance is formed, the conditioned compensatory response model—much like the conditioned withdrawal model and the opponent process theory—is unable to explain how stimuli paired with alcohol use can also be appetitive and incentivizing within the brain’s reinforcement system, particularly among individuals without physical or psychological dependence for alcohol (Mucha, Grier, Stuhlinger, & Mundle, 2000).

As an alternative to negative reinforcement based theoretical models, Stewart, DeWit, and Eikelboom (1984) proposed a conditioned appetitive motivational framework to explain motivations for alcohol use. Within this framework, Stewart et al. theorized that alcohol-use behaviors are maintained by appetitive motivational states generated by the ability of alcohol and

alcohol related stimuli to produce positive affective states. More specifically, alcohol-relevant stimuli become conditioned stimuli and produce positive reinforcing or “drug-like” properties. Motivation to use alcohol (i.e., subjective craving) is viewed as being intertwined with the availability of positive incentives and the affective value that a person places on those incentives at the time (Cox & Klinger, 1988). Despite the ability to make sense of the interactions between incentives and appetitive motivations among non-addicted individuals, positive reinforcement models of alcohol addiction have been unable to explain why individuals continue to use alcohol even when faced with the potential for vast negative consequences associated with its use (Robinson & Berridge, 1993). Given that classical conditioning based theories and positive and negative reinforcement based theories have been unable to provide a cohesive explanation of responses to alcohol cues or explain the mediating factors of continued alcohol use, more recent models of addiction have been considered.

The incentive-sensitization theory of addiction (Robinson & Berridge, 1993) hypothesizes that alcohol consumption, pathological drive cues, and associative learning following alcohol use, can over time, lead to attribution of incentive salience to alcohol and alcohol related cues and cause substance-related memory structures to undergo neural sensitization. In this process, incentive salience to alcohol occurs over time and through repeated exposure and begins to grab or ‘hijack’ attention causing alcohol to become craved or ‘wanted.’ This excessive incentive salience is theorized to create neural sensitization towards alcohol and alcohol related cues as well as implicit biases of attentional processing towards alcohol-related stimuli. Expanding upon previous models, incentive-sensitization theory hypothesized that neural sensitization following excessive incentivized salience can modulate an individual’s craving for alcohol but not their liking for alcohol. Thus, in a person dependent on

alcohol, the incentive salience of alcohol-related cues is not necessarily driven by pleasure derived from alcohol but out of neural sensitization and pathological ‘wanting’. Such excessive incentivized salience and neural sensitization to alcohol and alcohol related cues is theorized to be the process from which non-dependent drinkers can transition from liking alcohol to developing an explicit craving for alcohol (Robinson & Berridge, 2008). Given that incentive-sensitization theory can be used to explain the trajectory of alcohol reactivity across time, it holds promise in providing an understanding of how non-dependent drinkers respond to changes in their liking for alcohol and how their attentional biases toward alcohol may be influenced. While previous research has examined the relationships between alcohol attentional bias and alcohol craving (Field & Cox 2008; Field & Eastwood, 2005) as well as alcohol liking and alcohol craving (Ostafin et al., 2010) among non-dependent drinkers, no research has investigated the association of alcohol liking and alcohol attentional biases among non-dependent drinkers in a single study.

To examine how alcohol attentional biases are impacted following manipulation of alcohol liking, an adapted model of Robinson and Berridge’s (1993) incentive sensitization theory is proposed for non-dependent drinkers. Based on the framework of this model, non-dependent drinkers are theorized to have less exposure to the effects of alcohol over time and therefore lack excessive incentivized salience and neural sensitization. As such, non-dependent drinkers provide the opportunity to experimentally examine the impact of alcohol liking on alcohol attentional bias before physiological neurological effects of addiction occur producing pathological ‘wanting’ or craving for alcohol. Given this model, it is hypothesized that following manipulation of alcohol liking produces a salience towards alcohol and alcohol related cues (assessed via attentional bias). Framed within the nomenclature used in incentive sensitization

theory, it is proposed that the pleasure integrator works in parallel with the salience attributor in the absence of neural sensitization to create salience and direct attention toward alcohol and alcohol related stimuli. Supporting such an adaptation of incentive sensitization theory for non-dependent drinkers, research findings between alcohol attentional bias, alcohol craving, alcohol use behavior, alcohol consumption, and alcohol liking are presented below.

### **Attentional Bias and Craving**

A review of studies examining the correlation between alcohol attentional bias and alcohol craving among non-dependent drinkers has yielded conflicting results (Field, Christiansen, Cole, & Goudie, 2007; Field, Mogg, & Bradley, 2005; Field, Mogg, Zettler, & Bradley, 2004; Linden, Bechara, Bullens, Hanak, & Verbanck, 2006; Noel, Colmant, Van Den, 2006; Ramirez, Monti, & Colwill, 2015; Roberts & Fillmore, 2014; Taylor, Hwajung, & Cullen, 2013). Generally, findings suggest there is a moderate positive correlation between alcohol craving and alcohol attentional bias (Field et al., 2004; Field et al., 2005; Field, Christiansen, Cole, & Goudie, 2007); however, other studies suggest alcohol attentional bias and alcohol craving are unrelated (Noel et al., 2006; Ramirez et al., 2015; Roberts & Fillmore, 2014; Taylor et al., 2013). All studies used similar measures of attentional bias [i.e., a visual probe task (Posner, Snyder, Davidson, 1980)], with the exception of Field et al. (2007), who used an addiction Stroop task. Interestingly, findings appeared to differ based on the measure used to assess alcohol craving. Specifically, studies that assessed alcohol craving using the Desires for Alcohol Questionnaire (DAQ; Love, James, & Willner, 1998) demonstrated significant correlations with attentional bias (Field et al., 2004; Field et al., 2005; Field et al., 2007), while those that assessed alcohol craving using a single item or the Alcohol Use Questionnaire (AUQ;

Bohn, Krahn, & Stachler, 1995) demonstrated non-significant findings (Noel et al., 2006; Taylor et al., 2013; Ramirez et al., 2015; Roberts & Fillmore, 2014).

Discrepant findings were also found when alcohol craving was examined as a dichotomous, rather than continuous variable (Field et al., 2005; Hobson, Bruce, & Butler, 2013; Teunissen et al., 2012). Specifically, when alcohol craving was assessed using the DAQ, high alcohol cravers showed greater alcohol attentional biases compared to low alcohol cravers when assessed in a flicker paradigm as well as an eye tracking task (Hobson et al., 2013). However, when alcohol craving was assessed using the Obsessive-Compulsive Drinking Scale (OCDS), no significant difference between high and low alcohol cravers was found, even when using a visual probe task to assess alcohol attentional bias (Anton, Moak, & Lantham, 2010). Given these findings and the context of the assessment of alcohol craving, there appears to be initial support that non-dependent drinkers with high levels of craving for alcohol, assessed via the DAQ, are more likely to experience greater alcohol attentional bias.

### **Alcohol Use Behavior History**

To date, findings from studies examining attentional bias via the addiction Stroop, flicker paradigm, visual probe task, and eye tracking task suggest that alcohol attentional bias varies based on drinking history (Field et al., 2004; Field et al., 2007; Field et al., 2011; Hobson et al., 2013; Noel et al., 2006; Schoenmakers & Wiers, 2010). A review of studies using the addiction Stroop and the flicker paradigm suggest that heavier drinkers exhibit a greater general attentional bias towards alcohol cues compared to their lighter drinking counterparts (Field et al., 2007). Furthermore, results suggest that heavy drinkers exhibit a greater bias in maintenance of attention (e.g., time spent looking at alcohol vs. neutral cues) when alcohol cues are presented for longer durations (e.g., 500 ms or 2000 ms) compared to light drinkers (Field et al., 2004;

Field et al., 2011). However, when alcohol-related cues are presented for shorter durations (e.g., less than 200 ms), biases in initial orienting of attention (e.g., the proportion of trials in which initial gaze is directed toward alcohol cues vs. neutral cues) are non-significantly different between heavy and light drinkers (Field et al., 2004; Hobson et al., 2013; Noel et al., 2006). Based on these findings, there appears to be correlational support showing that heavy drinkers may have a significantly greater maintenance of attention towards alcohol cues than their light-drinking counterparts.

Regarding the relationship between alcohol craving and drinking history, results from three studies suggest that heavy drinkers have significantly higher levels of craving for alcohol than their light drinking counterparts (Field et al., 2004; Field et al., 2007; Schoenmakers & Wiers, 2010). Looking specifically at studies measuring craving with the DAQ (e.g., Field et al., 2004; 2007), findings indicate that heavy drinkers have significantly higher levels of craving for alcohol than light drinkers. Moreover, when alcohol craving was assessed using the AUQ and visual analog scales, results further supported the finding that heavy drinkers have significantly more alcohol craving than light drinkers. Based on these combined results, there appears to be evidence that alcohol craving is associated with one's history of alcohol use behaviors as predicted by Robinson and Berridge (2003).

### **Alcohol Consumption**

Based on the adapted model of Robinson and Berridge's (1993) incentive-sensitization theory, alcohol attentional bias is predicted to be associated with increases in subjective pleasure following alcohol consumption. To date, three studies have investigated the impact of alcohol consumption on alcohol attentional biases and alcohol craving (Duka & Townshend, 2004; Roberts & Fillmore, 2014; Schoenmakers, Wiers, & Field, 2008). To test this effect, Duka and

Townshend examined changes in alcohol attentional bias among non-dependent drinkers using a visual probe task following consumption of either a low dose (0.3g/kg) or high dose (0.6g/kg) of alcohol. Drinkers had increased bias of maintenance attention toward alcohol cues when given low doses but not high doses of alcohol. In a follow-up study, Schoenmakers et al. examined changes in alcohol attentional bias among non-dependent drinkers using an eye-tracker and a visual probe task following alcohol priming using low doses of alcohol (0.3g/kg). Results of the visual probe task replicated earlier findings that alcohol priming with low doses of alcohol are sufficient to produce biases in maintenance of attention toward alcohol related cues.

Additionally, results suggested that low doses of alcohol also produce biases in initial orienting of attention as well as maintenance of attention toward alcohol related cues when assessed via eye movements. Based on these findings, low doses of alcohol appear to significantly increase biases in maintenance of attention as well as initial orienting of attention toward alcohol cues.

Duka and Townshend (2004) posited that the lack of attentional bias at high alcohol priming dosages (0.6 g/kg), as seen by Schoenmakers et al. (2008), was related to a satiation effect in which the attention-grabbing properties of alcohol-related cues were purported to become less salient. A recent investigation showed that such a satiation effect may not only be present but may be more temporary than previously thought. Specifically, Roberts and Fillmore (2014) examined changes in attentional bias toward alcohol cues assessed via a visual probe task following alcohol priming with a high dose of alcohol (0.64g/kg). Results showed that attentional bias for alcohol significantly decreased following consumption of a high dose of alcohol, particularly during the ascending curve of the breath alcohol concentration. However, as breath alcohol level descended under an active dose, alcohol attentional bias returned to a level comparable with that of a non-intoxicated state. Given these findings, it appears that

attentional biases toward alcohol cues may be significantly increased with low doses of alcohol but also may be significantly decreased with intoxicating levels of alcohol (Roberts & Fillmore, 2014). These findings provide further support that manipulation of attentional bias is possible with consumption of low doses of alcohol and may be due in part to one's liking for alcohol in the absence of the impairing effects of alcohol intoxication.

### **Alcohol Liking**

Despite the strong conceptual differences between alcohol craving and alcohol liking as described by Robinson and Berridge (1993), only two studies (i.e., Hobbs, Remington, & Glautier, 2005; Ostafin, Marlatt, & Troop-Gordon, 2010) have empirically tested both alcohol liking and alcohol craving among non-dependent drinkers. In a series of experiments, Hobbs et al. sought to examine (a) if differences in liking existed between heavy and light drinkers, (b) whether alcohol consumption affected heavy and light drinkers' subjective liking for alcohol, and (c) whether alcohol liking and alcohol craving could be further dissociated by experimentally manipulating liking and examining related changes in craving. Their first experiment revealed no significant difference between heavy and light drinkers on liking for alcoholic beverages, suggesting that heavy and light non-dependent drinkers may not differ in their baseline liking for alcohol. However, their second experiment showed that the amount of alcohol consumed during a taste test paradigm (considered to be a measure of craving) was not associated with liking ratings of alcohol. Lastly, their third experiment showed that flavor adulteration of an alcoholic beverage, which was strong enough to reduce subjective liking of alcohol, had no impact on one's alcohol craving (conceptualized as the amount of adulterated alcoholic beverage the individual consumed). Based on these findings, there appears to be support that alcohol liking and alcohol craving are distinct constructs, that liking for alcohol can

be effectively reduced by altering the flavor profile of an alcoholic beverage, that reduction of alcohol liking may not significantly reduce alcohol craving, and that history of alcohol use may not significantly relate to a non-dependent drinker's liking for alcohol. Of note, however, researchers in this study inferred craving based on participants alcohol consumption but did not include a direct measure of craving.

To further examine the proposition that one is able to differentiate between liking for alcohol and wanting for alcohol, Ostafin et al. (2010) expanded upon the Hobbs et al. (2005) initial findings. Specifically, Ostafin et al. sought to test two propositions of incentive sensitization theory—that liking and craving for alcohol are separable and that repeated alcohol use results in increased craving for alcohol and decreased liking for alcohol. The researchers hypothesized that (a) alcohol liking and alcohol craving would uniquely predict alcohol consumption, (b) the relation between alcohol craving and alcohol consumption would be stronger for those who have a greater history of drinking alcohol, and (c) the relation between alcohol liking and alcohol consumption would be weaker for those with a greater history of drinking alcohol. Ostafin et al. found that after controlling for alcohol craving, alcohol liking had only a modest association with alcohol consumption. In addition, they demonstrated that the relationship between alcohol craving and alcohol consumption remained significant after controlling for alcohol liking. Additionally, they showed that the longer history an individual has with alcohol consumption, the weaker the relationship that exists between alcohol liking motivation and alcohol consumption. However, their results showed that drinking history did not moderate the relationship between consumption of alcohol and craving for alcohol. Overall, these combined findings support the importance of the role of alcohol liking within the incentive sensitization model (Robinson & Berridge, 1993) for non-dependent drinkers. However, these

findings do not address how alcohol liking may impact alcohol attentional bias among non-dependent drinkers.

### **Current Study**

As outlined above, there appears to be preliminary support for the proposed examination of alcohol liking and alcohol attentional bias using a modified model of incentive sensitization theory for non-dependent drinkers. Specifically, previous research suggests that—alcohol liking and alcohol craving are associated yet distinguishable, alcohol attentional bias and alcohol craving have been shown to be positively associated with one another, and that alcohol use behavior has been associated with variances in alcohol attentional bias as well as craving for alcohol among non-dependent drinkers. Despite these findings, the potential relationship between alcohol attentional bias and alcohol liking has not been examined. Therefore, the current study aimed to directly test how manipulation of alcohol liking may influence attentional bias toward alcohol cues among non-dependent drinkers in a controlled setting. To address these study aims, a sample of legal-aged, college student, non-dependent drinkers were recruited for a laboratory-based repeated-measures experiment. Participants first completed background measures, followed by two counterbalanced beer tasting conditions [cold beer (“like” condition) versus warm beer (“dislike” condition)] and two counterbalanced cracker tasting conditions (administered to obscure the true purpose of the study). Following each beer consumption condition, participants completed measures of alcohol liking and alcohol craving as well as a visual probe task to assess maintenance of attention (e.g., where individuals attend after cognitively processing a presented cue).

Consistent with the adapted model, a reduction in alcohol liking following the “dislike” condition was expected to result in less attentional bias towards alcohol cues compared to the

“like” condition intended to increase alcohol liking. The following hypotheses, which were based on the adaptation of the incentive sensitization model of addiction, were posed with acknowledged limitations such that all components of the integrated model are unable to be tested (e.g., the impact of liking manipulation on consumption of alcohol and the role of pathological wanting/craving):

1. Participants would demonstrate lower alcohol attentional bias following the warm beer condition compared to the cold beer condition.
2. Liking ratings following cold and warm beer consumption would be positively associated with alcohol attentional bias.

## METHOD

### **Participants**

The study sample consisted of 53 volunteers recruited through a combination of a University subject pool and from the general campus via advertisements. Participants were screened for meeting eligibility criteria (described in the Procedures), which were consistent NIAAA (2005) guidelines for alcohol administration research in humans. Participants were predominantly male (67.9%) with a mean age of 23.49 ( $SD = 3.92$ ; range = 21-41 years). The majority of participants identified as White, Caucasian, or Non-Hispanic (67.9%) or White Hispanic/Latino (13.2%). Other ethnicities included those who identified themselves as African-American/Black, Non-Hispanic (7.5%), Asian, Asian American or Pacific Islander (5.7%), Black Hispanic/Latino (3.8%), and Other (1.9%). All participants were currently enrolled students at a public mid-southern university in the United States and were primarily undergraduates (96.2%). The majority of participants were unemployed (54.7%). Of those employed, the majority

reported part time employment (66.7%). See Table 1 for a complete summary of participant demographic information.

G\*Power software (Erdfelder, Faul, & Buckner, 1996) was used to determine the necessary sample size for this study based on the findings of Hobbs et al. (2005) which examined the effect of using a beverage adulterant to manipulate liking alcohol in a repeated measures design among both heavy and light drinkers. The standardized mean difference effect size for the within-subjects design (Cohen's  $d_z$ ) was calculated using the formula ( $d_z = t_w / \sqrt{n}$ ), where  $t_w$  is the paired-samples  $t$ -statistic and  $n$  is the number of subjects. Given that Hobbs et al. examined manipulation of liking using a repeated-measures design among heavy and light drinkers, Cohen's  $d_z$  effect sizes of the two groups ( $d_z = .83$  for heavy drinkers) and ( $d_z = .14$  for light drinkers) were averaged which provided an estimated effect size of .49. According to an a priori power analysis for a repeated measures  $t$ -test, with alpha set at .05, and power at .80, the necessary sample size was calculated to be 35 participants. However, given the magnitude of the relationship between alcohol liking and alcohol attentional bias was unknown, a minimum sample of size of 50 was chosen.

## Measures and Stimuli

**Demographics.** Participants provided basic demographic information, including gender, age, race/ethnicity, employment, education, current student status, income, and sexual orientation (see Table 1).

**Drink Type Preference (DTP).** To assess alcohol drink preferences, participants ranked their preferred beverage on a scale from (1) (*Least preferred*) to 8 (*Most preferred*), using each number only once. Participant DTP was assessed for the following beverages: Beer, Wine, Wine Cooler, Mixed Drink (Cocktail), Fortified Wine, Hard Liquor (Distilled Spirits), Liqueurs, and

Champagne. Each participant's DTP was determined by identifying the beverage ranked as most preferred.

***The AUDIT Alcohol Consumption Questions (AUDIT-C).*** The 3-item AUDIT-C (Babor, Higgins-Biddle, Saunders, & Monterio, 2001) was used to assess the quantity and frequency of alcohol use with the exclusion of dependence symptoms and harmful consequences related to drinking. The internal consistency of the AUDIT-C ( $\alpha = .84$ ) has been shown to be high (Gomez, Conde, Santana, & Jorin, 2005). The mean score in the present sample was 5.13 ( $SD = 1.93$ ) and Cronbach's alpha was .66.

***Adult Self-Report Scale v1.1 (ASRS).*** The ASRS is a screening instrument by Kessler et al. (2005) that was developed by the World Health Organization in order to provide initial information about the prevalence of ADHD symptoms for both research and health-care centers. It is derived from the criteria for ADHD in the DSM-IV. Part A includes the six most predictive items while part B holds an additional 12 items, all rated on a 5-point scale (0 = *never*, 1 = *rarely*, 2 = *sometimes*, 3 = *often*, and 4 = *very often*). The ASRS has been shown to have an internal consistency ranging from .63 to .72 (Kessler, Adler, Gruber, Sarawate, Spencer, & VanBrunt, 2007). The internal consistency for the current study was .56.

***Eating Attitudes Test (EAT-26<sup>©</sup>).*** The EAT-26 (Garner et al., 1982) is a 26-item questionnaire designed to identify abnormal eating habits and concerns about weight. Participants rate the intensity of attitudes from six possible options *Never* (coded as 0), *Rarely* (0), *Sometimes* (0), *Often* (1), *Very Often* (2), and *Always* (3). A score greater than 20 is considered to be an indicator of a possible eating disorder problem. The EAT-26 has been shown have an internal consistency ranging from .70 to .88 (Doninger, Enders, & Burnett, 2000). The internal consistency for the current study was .66.

**General Craving.** The Desires for Alcohol Questionnaire (DAQ) contains 14 items that assess intentions to drink alcohol, desires to consume alcohol, anticipation of positive outcomes from drinking, and anticipation of relief of negative affect or alcohol withdrawal. Items are rated on a 7-point Likert-type scale from 1 (*not at all likely*) to 7 (*extremely likely*). The DAQ, assessed using a total score, has shown high internal consistency, with a Cronbach's alpha of .96 (Love, James, & Willner, 1998). The internal consistency of DAQ total scores for both the cold and warm craving manipulations was .84.

**Alcohol Liking.** Participants were asked to rate their liking for alcohol on a 5-item measure assessing their perceived level of enjoyment, satisfaction, deliciousness, liking, pleasantness following alcohol consumption. Items were scored on 4-point Likert-type scale ranging from 0 (*not at all*) to 4 (*very much*). Items in the current study were expanded upon from earlier explicit measures of alcohol liking used by Hobbs et al. (2005) and Ostafin et al. (2010) to include ratings of enjoyment and how pleasant they found the drink consumed. The current alcohol liking measure, assessed using a total score, showed high internal consistency, with a Cronbach's alpha of .95 across both the cold and warm liking conditions.

**Visual Probe Task.** Each trial started with a central fixation cross shown for 500 ms, which was replaced by the display of a pair of pictures (alcohol and matched control non-alcohol cues), side by side, for 2000 ms. The probe duration of 2000 ms, which assesses maintenance of attention (e.g., where individuals continue to pay attention after cognitively processing a presented cue), was chosen due to the research support suggesting that non-dependent drinkers exhibit a significant bias in maintenance of attention toward alcohol cues (e.g., Field et al., 2004 and Field et al., 2011). Immediately after the offset of the picture pair, a probe was presented in the position of one of the preceding pictures, and remained visible until the participant's

response. Participants were instructed to press one of two response buttons to indicate position of the probe on the screen. Participants were instructed to respond as quickly as possible to the location of the probe. Responses were recorded on an Empirisoft DirectIN High Speed Button-Box allowing collection of response data in less than 1 ms. The inter-trial interval was variable and participants initiated the start of each trial. Reaction times to probes that appeared where the alcohol-related stimuli were located were compared against reaction times to probes that appeared where the control stimuli appeared. Attentional bias for alcohol cues was inferred through participants responding faster to probes that replaced alcohol cues compared to control cues. This inference is based upon the assumption that participants respond faster to probes that appear in the region of the visual display that they were already attending (Posner, Snyder, & Davidson, 1980).

A total of 20 alcohol pictures containing five pictures of each beer, wine, cocktails, and hard liquor (Lovett, Ham, & Veilleux, 2015) were presented in the visual probe task. All pictures exclude evocative stimuli such as labeling, advertising, or branding, and were taken in a simulated bar setting using a simple background. The utilized cues have been shown to have good psychometric support (i.e., factorial, convergent, incremental, and discriminant validity, and internal consistency) in eliciting craving. A total of 20 control stimuli containing pictures of bottles, mugs, and cups depicting water, juice, coffee, and other non-alcoholic drinks (Veilleux, Lovett, Skinner, & Ham, in press) were also presented in the visual probe task as control cues. Control pictures similarly excluded evocative stimuli such as labeling, advertising, or branding, and were taken in a simulated bar setting using a simple background. A total of 80 trials (20 picture pairs) were presented four times each. Specifically, the response probe appeared on the right side of the screen following the alcohol picture (20 trials), the response probe appeared on

the left side of the screen following the alcohol picture (20 trials), the response probe appeared on the right side following the control picture (20 trials), and the response probe appeared on the left side following the control picture (20 trials). See Data Analytic Plan regarding detail of attentional bias calculation.

## **Procedures**

Individuals were recruited through the use of flyers and online advertisements. Individuals were advised that participation would include consumption of beer as well as consumption of crackers. Individuals were informed the study was examining their reactions and perceptions to alcohol and food to help mask the main hypotheses from participants' awareness. Participants were selected on the basis of a semi-structured phone interview and had to meet the following six eligibility requirements: a) were 21 years of age or older; b) did not self-identify as an alcoholic or self-identify as currently recovering, abstaining or trying to abstain from alcohol consumption; c) did not self-endorse medical conditions (including alcoholism), or regular ingestion of medications that are contraindicated for use with alcohol; d) had at least two alcoholic beverages in one sitting in the previous 30 days without adverse effect; e) were a current beer drinker with no beer or gluten allergies; and f) were not currently pregnant, planning to become pregnant, or feel there may be a chance they are pregnant. Eligibility for the study was dependent on an individual's AUDIT score below 16, as a score above 15 has been shown to indicate individuals who may need brief counseling, continued monitoring, or further diagnostic evaluation for alcohol dependence (Babor, Higgins-Biddle, Saunders, & Monteiro, 2001). Also, each individual was screened to ensure an initial breath alcohol concentration of .000% assessed with an Intoximeter Alco-Sensor FST Breathalyzer.

Eligible participants were asked to sign a behavioral contract requiring them to agree to abstain from driving following the study. Eligible participants were also required to provide a valid driver's license or other government issued picture ID (e.g., passport) for confirmation of legal drinking age. Female participants were required to take a pregnancy test prior to consumption of alcohol per federal guidelines for administering alcohol to humans (NIAAA, 2005).

Following acceptance into the study, participants read and signed a consent form and were given written instructions about the study. Participants then completed questionnaires administered by an online survey service (Qualtrics<sup>®</sup>) that included demographics and measures of alcohol drink type preference, alcohol use behavior, eating attitudes, and assessment of symptoms related to inattention and hyperactivity. Following completion of questionnaires, participants were served one of two randomized types of similar flour-based crackers. Participants were informed that they were to consume five crackers in 10 minutes, following which they were asked to provide a liking rating for the crackers they consumed. Next, participants were served a mixture of 6 ounces of domestic light lager beer and 6 ounces of non-alcoholic domestic light lager beer in order to minimize peak blood alcohol concentration. Participants were randomly assigned to either first receive (1) a cold beer mixture which was carbonated and its original coloring, or (2) a warm beer mixture which lacked carbonation and had its coloring altered with brown food coloring. This manipulation was shown to be effective in pilot testing.<sup>1</sup> Participants were allotted 10 minutes to consume their first alcoholic beverage. Following consumption, participants were asked to complete ratings of their current liking for

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<sup>1</sup> Pilot data previously collected from 10 participants supported the effectiveness of the liking manipulation. Participants reported significantly higher liking ratings in the cold beer condition ( $M = 16.9$ ,  $SD = 3.96$ ) than the warm beer condition ( $M = 7.5$ ,  $SD = 2.72$ ),  $t(9) = 11.87$ ,  $p < .001$ .

the consumed beverage as well as their general craving for alcohol. Next, participants completed the visual probe task to assess their alcohol attentional bias. Following the visual probe task, participants were served the second set of five flour-based crackers with a 10-minute consumption time limit. Following consumption of the second set of crackers, participants again rated their liking for the crackers. Participants then consumed the second of the two alcoholic beverages, where participants were again allotted 10 minutes to consume their drink. Participants then completed ratings of current liking for the beverage, a measure of general craving for alcohol, and the visual probe task again to assess alcohol attentional bias following the second beverage.

Following the second visual probe task, and prior to the conclusion of the study, participants' blood alcohol concentrations were recorded to ensure they were in a range legally defined as safe (< .040%). Participants were also debriefed, verbally reminded of their agreement to abstain from driving following the study, provided their compensation, and then thanked and excused from the study. Participants that were enrolled in a general psychology course were compensated 1.5 course required research credits through SONA<sup>®</sup>. Students not enrolled in a general psychology course were compensated \$15.00 in cash.

## RESULTS

### **Data Analytic Plan**

Attentional bias (reaction time difference scores) scores for the trials were calculated based on formulas used in prior research studies such that mean reaction time on trials where the alcohol cue and the response probe appear on the same side of the display were subtracted from the mean reaction time on trials where the response probe and control cue appeared on the same side of the display (Field et al., 2013). The formula in the current study was:  $M(\text{Control Cue RT})$

-  $M(\text{Alcohol Cue RT}) = \text{RTDifference}$ . With this formula, positive values indicate attentional bias toward alcohol cues, whereas negative values indicate attentional bias towards control cues.

Prior to the primary data analyses, preliminary analyses were conducted to complete data cleaning and to check for violations of statistical assumptions. Specifically, frequencies and descriptive analyses were examined to determine data errors, appropriate coding of variables, and to remove cases with outliers. Next bivariate correlations were calculated with variables potentially associated with participants' alcohol liking and alcohol attentional bias, including alcohol craving, alcohol use behavior (AUDIT-C), age, inattention / hyperactivity (ASRS), the time participants took to consume their beer, and eating attitudes (EAT-26<sup>©</sup>). Next, univariate analyses of variance (ANOVAs) were conducted to examine the effects of gender, compensation, drink order, cracker order, and drink type preference on participants' alcohol liking and alcohol attentional bias following alcohol manipulation. Additionally, a paired sample *t*-test was conducted to examine whether participants took significantly different amounts of time consuming cold vs. warm beer.

As a manipulation check, a dependent-samples *t*-test was conducted for alcohol liking ratings following cold beer consumption and warm beer consumption. To examine the first hypothesis, a paired samples *t*-test was conducted to examine differences in alcohol attentional bias between the warm and cold conditions. To examine the second hypothesis, bivariate correlations were conducted between liking ratings and alcohol attentional bias for each for cold and warm beer conditions.

### **Data Cleaning**

Self-report data were examined for missingness, normality, and the presence of outliers (3+ standard deviations outside the mean). The data of two participants were excluded from

analyses examining alcohol attentional bias due to computer error and loss of data. Reaction times in the visual probe task were discarded if the participant took more than 3000 ms to respond on single image-pair presentation, and/or they were more than 3 standard deviations above their average response time, consistent with Field et al. (2013). Overall, 0.01% of attentional bias scores following the cold beer manipulation and < 0.01% of attentional bias scores following the warm beer manipulation resulted in outlier data points. Wine coolers, liqueurs, champagne, and fortified wine were excluded from preliminary analyses investigating drink type preference due to beer, mixed drinks, wine, and hard liquor being preferred by 94.7% of the sample. There were no extreme outliers on AUDIT-C, ASRS, DAQ, EAT-26<sup>©</sup> or measures of alcohol liking or alcohol craving. See Table 1 for demographic and questionnaire frequencies.

### **Preliminary Analyses**

Based on bivariate correlations, alcohol use behavior was shown to be positively correlated with the cold beer conditions but unrelated to the warm beer conditions or alcohol attentional bias in either the cold or warm conditions. Age, symptoms associated with inattention / hyperactivity, time participants took to consume beer, eating attitudes, order of drink presentation, and order of cracker presentation were unrelated to alcohol liking or alcohol craving in either beer condition. See Table 2 for means, standard deviations, and correlation coefficients.

Based on univariate ANOVAs, male participants reported higher alcohol liking ratings than female participants in the cold beer condition, but no significant differences were found in the warm beer condition. No significant differences of alcohol attentional bias were found between men and women in either alcohol liking condition. Alcohol attentional bias did not significantly differ based on type of compensation (SONA<sup>®</sup> vs \$15) between alcohol liking

conditions. Participants who received \$15 however, had significantly higher alcohol liking rating in the warm beer condition compared those given SONA<sup>®</sup> credit. No significant effect of compensation type was found in the cold beer condition. Alcohol attentional bias was found to significantly differ between participant drink type preferences in the cold beer condition but not the warm beer condition. In the cold beer condition, post-hoc comparisons using the Bonferroni correction revealed that alcohol attentional bias was lower among participants who prefer wine compared those who prefer beer ( $p = .016$ ), mixed drinks ( $p = .003$ ), and hard liquor ( $p = .035$ ). See Tables 3 and 4 for means, standard deviations,  $F$  values, and  $p$ -values for analyses involving gender, compensation, drink order, cracker order, and drink type preference.

Using paired-sample  $t$ -tests, participants were found to consume beer in the cold beer condition ( $M = 175.71$  seconds,  $SD = 125.02$ ) significantly slower than they consumed beer in the warm beer condition ( $M = 147.25$  seconds,  $SD = 104.24$ ),  $t(50) = -2.31$ ,  $p = .025$ .

Despite significant correlations within the preliminary analyses, variables such as gender, ASRS, compensation, and DTP were not entered as covariates in primary analyses as they may not be meaningful due to the fact that the repeated-measures design should account for background differences. Additionally, the AUDIT-C was excluded as a covariate in primary analyses and was instead examined as a potential moderator in the relationship between alcohol liking and alcohol attentional bias due to how incentive sensitization theory conceptualizes the impact of repeated alcohol use behavior on the salience of alcohol cues.

## **Primary Analyses**

### *Manipulation Check*

A dependent-samples  $t$ -test showed that alcohol liking ratings following warm beer condition were significantly lower than alcohol liking ratings following cold beer condition,

$t(51) = 9.87, p < .001$ . See Table 5 for means and standard deviations for liking ratings across conditions.

### *Hypothesis 1*

Alcohol attentional bias following the warm beer condition was not significantly lower than alcohol attentional bias following cold beer condition,  $t(50) = 0.16, p > .05$ . See Table 5 for means and standard deviations for alcohol attentional bias following warm and cold conditions.

### *Hypothesis 2*

As shown in Table 5, alcohol attentional bias was not found to be associated with liking ratings in either the warm or cold beer conditions.

### **Follow Up Analyses**

Based on correlational support showing that heavier drinkers have a significantly greater maintenance of attention towards alcohol cues than their lighter-drinking counterparts, follow up analyses were conducted to examine whether the effects of alcohol liking manipulation on alcohol attentional bias were moderated by alcohol use behavior. Two 5000 bias-corrected bootstrapped sample Hayes PROCESS moderation macros (Model 1) were analyzed, one each for the cold beer condition and warm beer condition. Alcohol liking rating following the manipulation was entered as the independent variable (x), alcohol attentional bias following the manipulation was entered as the dependent variable (y), and AUDIT-C was entered as the moderator (m).

For the cold beer condition, the model was statistically significant and the main effects and interaction term accounted for 13% of the variability in alcohol attentional bias following cold beer consumption,  $F(3, 47) = 3.29, p = .029$ . AUDIT-C was not a significant predictor of alcohol attentional bias following cold beer consumption ( $B = 1.85, SE = 1.21, p = .13$ ).

Additionally, liking rating for the cold beer was also not a significant predictor of alcohol attentional bias following cold beer consumption ( $B = -.11, SE = .40, p = .79$ ). The interaction between cold beer liking rating and the AUDIT-C, however, was significant ( $B = .37, SE = .14, p = .009$ ). The significant interaction was probed by testing the conditional effects of the cold beer manipulation on alcohol attentional bias at three levels of AUDIT-C, one standard deviation below the mean, at the mean, and one standard deviation above the mean. The conditional effect of the cold beer liking rating on alcohol attentional bias following cold beer consumption was marginally significant when AUDIT-C was one standard deviation below the mean ( $B = -.84, SE = .43, p = .057$ ), suggesting a trend for increased liking ratings to be related to decreased attentional bias following cold beer consumption for lighter drinkers (see Figure 1). Liking rating was unrelated to attentional bias following cold beer consumption when AUDIT-C scores were at the mean ( $B = -.11, SE = .40, p = .79$ ) or one standard deviation above the mean ( $B = .62, SE = .53, p = .25$ ).

When examining the main effects and interaction term for the warm beer condition, the model was not statistically significant and only accounted for 3% of the variability in alcohol attentional bias,  $F(3, 47) = .44, p = .72$ .

Additionally, to demonstrate that alcohol liking and alcohol craving are related, yet still distinct, follow up analyses examined how alcohol craving was associated with the manipulations of alcohol liking. As shown in Table 5, alcohol craving was found to be positively correlated with the liking manipulation in both beer conditions. Additionally, alcohol craving ratings in the warm beer condition were significantly (but not meaningfully) lower than alcohol craving ratings in the cold beer condition,  $t(50) = 2.51, p = .015$ .

## DISCUSSION

The current study utilized a proposed adapted model of incentive sensitization theory (Robinson and Berridge, 1993) to examine the impact of alcohol liking on alcohol attentional bias among non-dependent college drinkers. Based on the framework of this model, non-dependent drinkers were theorized to have less exposure to the effects of alcohol over time and therefore lack excessive incentivized salience and neural sensitization. As such, non-dependent drinkers provide the opportunity to experimentally examine the impact of alcohol liking on alcohol attentional bias before physiological neurological effects of addiction occur. Given this model, it was hypothesized in the current study that manipulation of alcohol liking among non-dependent drinkers would produce a salience towards alcohol and alcohol related cues (assessed as maintenance of attention, which is defined as continuing to pay attention after cognitive processing a presented cue). Furthermore, the current study hypothesized that alcohol attentional bias would be positively associated with the manipulation of alcohol liking.

Results showed that alcohol liking ratings following warm beer consumption were significantly lower than alcohol liking ratings following cold beer consumption, providing evidence of an effective manipulation of liking within the study. The liking manipulation did not result in differences in alcohol attentional bias, which is contrary to the hypothesized results and inconsistent with the proposed model based upon the incentive sensitization theory. Further, alcohol attentional bias was not found to be significantly associated with liking ratings in either the cold or warm beer conditions. Follow-up analyses examined whether alcohol use behavior moderated the association between alcohol liking rating and alcohol attentional bias following each condition. A significant cold beer liking rating x alcohol use behavior interaction was found, with marginally significant inverse association between liking rating and attentional bias

following cold beer consumption for light drinkers. The lack of significant conditional effects were likely due to low statistical power to test interaction effects. No moderation effect was found in the warm beer manipulation. Together, findings suggest that alcohol use behavior may play an important role in the relationship between alcohol liking and alcohol attentional bias among non-dependent drinkers.

Additionally, follow-up analyses showed that liking in both beer conditions was correlated positively with alcohol craving ratings. Further, alcohol craving ratings following the warm beer condition were significantly lower than the cold beer condition; however, these results should be interpreted with caution as the change in craving ratings (43.62 vs. 45.96) are not considered meaningful.

This current study contributes to the literature related to models of alcohol use in that it is the first known study to examine the effect of alcohol liking on attentional bias among non-dependent drinkers, using the framework of a modified model of incentive sensitization. In addition, the current study provided a unique opportunity to examine alcohol liking as a consummatory rather than an anticipatory state due to alcohol liking assessment following rather than preceding alcohol consumption. It is important to note that the current study also raises some questions about the adapted theoretical model. Specifically, the current finding that alcohol attentional bias was not significantly different across the warm and cold beer conditions is surprising within the framework of the proposed model, assuming the effects of an alcohol liking manipulation on alcohol attentional bias are as robust as those seen in dependent drinker populations. Additionally, it may be possible that attentional bias was incorrectly adapted into incentive sensitization theory in this initial proposed model. Another possible explanation for the surprising results related to attentional bias and the effects of a liking manipulation may be that

the proposed adaptation incorrectly predicted that momentary manipulation of alcohol liking would have a substantial impact on alcohol attentional biases among non-dependent drinkers. As such, it may be that due to a lack of incentivized salience among non-dependent drinkers that makes them less susceptible to changes in attentional bias following manipulation of their subjective liking for alcohol.

### **Limitations**

There were notable limitations in the methods and design of the current study that should be considered during interpretation of findings. First, the mediating role of attentional bias on the relationship between liking manipulation and alcohol craving was unable to be examined due to two design-related challenges, namely: 1) the temporal order of when alcohol craving ratings were collected (i.e., alcohol craving was assessed following consumption of beer and prior to assessment of alcohol attentional bias); and 2) the challenges of examining an anticipatory state (i.e., craving) in a laboratory-based experimental study that uses a theoretical model that describes the development of pathological craving occurring over time. Also, given that baseline measures of alcohol liking, alcohol craving, and alcohol attentional bias were not collected prior to alcohol consumption, investigations into the effect of alcohol consumption, alcohol priming, and in vivo exposure are unable to be examined. In addition, the sole use of a 2000 ms cue presentation time in the visual probe task (assessing maintenance of attention), may have contributed to fatigue or expectancy based reaction times among participants and excluded the possibility of examining orientation of attention (e.g., the proportion of trials in which initial gaze is directed toward alcohol cues vs. neutral cues) which, as discussed, has been previously shown increase following low doses of alcohol. Additionally, the current study's participation restriction to individuals with an AUDIT score lower than 16 prevented examination of the

association between liking conditions and alcohol attention bias among a heavier drinking, yet non-dependent, sample of drinkers. Furthermore, the current study relied on self-report measures as well as indirect assessments of alcohol attentional bias (i.e., visual probe tasks), both of which may limit the interpretability and generalizability of the findings. Lastly, the proposed model assumed that alcohol attentional bias could be affected following brief manipulation of one's alcohol liking and the current study is likely underpowered to detect such a change.

### **Future Directions**

Alcohol liking and attentional bias are still believed to be critical components in understanding the trajectory of non-problem drinking to problem alcohol use and alcohol use disorders. The examined theoretical model presents a complex process which may be limited in its conceptual testability among non-dependent drinkers in a laboratory setting. As such, future studies may benefit from consideration of the following recommendations. First, future research would benefit from including mixed alcohol cue presentation times that both capture orientation of attention (e.g., 200ms and 500ms) as well as maintenance of attention (e.g., 1000ms and 2000ms). Second, as highlighted by Field et al. (2012), the inclusion of both indirect (e.g., visual probe) and direct assessments of visual selective attention (e.g., eye-movement tracking) may increase the overall reliability of attentional assessment by allowing for simultaneous assessment of initial orientation of attention (proportion of trials in which initial gaze is directed toward alcohol cues vs. neutral cues) as well as maintenance of attention (time spent looking at alcohol vs. neutral cues). Moreover, eye-movement tracking has also been shown to be an ecologically valid and directly observable measure of attentional bias and has been supported as a complementary measure to be used alongside visual probe tasks (Field et al., 2011; Roberts & Fillmore, 2014; Schoenmakers et al., 2008). Fourth, given the significant interaction of alcohol

use behavior and alcohol liking on alcohol attentional bias in the cold condition, further examination of the potential moderating effect of alcohol use behavior on the alcohol liking and attentional bias association is warranted. Finally, an expanded review of the literature should be performed to examine the potential impact of other variables that have been shown to be associated with alcohol attentional bias among non-dependent drinkers such as stress, drinking motives, negative affect, and even exercise (Baker et al., 2004; Field & Powell, 2007; Field & Quigley, 2009).

## **Conclusion**

Taken together, the current findings provide an initial investigation into the role of alcohol liking on attentional bias in an adapted theoretical model of incentive sensitization theory originally proposed by Robinson and Berridge (1993). No previous study has examined the effect of liking manipulation on alcohol attentional bias utilizing a within-subjects design in which alcohol liking was manipulated by beer type. Despite the current findings not supporting the proposed model, it is still believed that alcohol liking and attentional bias are critical components associated with alcohol use behavior. The current study raised important considerations for theoretical models examining the relationship between alcohol liking and alcohol attentional bias. Further research is needed to understand whether a momentary manipulation of one's alcohol liking is adequate to make both sufficient as well as meaningful changes in alcohol attentional bias among non-dependent drinkers.

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## Appendix

Table 1.  
Demographic Summary

<b>Gender</b>	Male	67.9%	<i>n</i> = 36
	Female	22.1%	<i>n</i> = 17
<b>Race/Ethnicity</b>	Asian, Asian American, or Pacific Islander	5.7%	<i>n</i> = 3
	White (Caucasian/non-Hispanic)	67.9%	<i>n</i> = 36
	Other	1.9%	<i>n</i> = 1
	Hispanic/Latino (Black)	3.8%	<i>n</i> = 2
	Hispanic/Latino (White)	13.2%	<i>n</i> = 7
	African American / Black (non-Hispanic)	7.5%	<i>n</i> = 4
<b>Age</b>	20-29	90.6%	<i>n</i> = 48
	30-39	7.5%	<i>n</i> = 4
	40-49	1.9%	<i>n</i> = 1
	50-59	0%	<i>n</i> = 0
	60-69	0%	<i>n</i> = 0
<b>Education</b>	Freshman	7.5%	<i>n</i> = 4
	Sophomore	15.1%	<i>n</i> = 8
	Junior	34%	<i>n</i> = 18
	Senior	39.6%	<i>n</i> = 21
	Graduate/Professional	3.8%	<i>n</i> = 2
<b>Employment</b>	Currently Employed	45.3%	<i>n</i> = 24
	Not Currently Employed	54.7%	<i>n</i> = 29
<b>Employed Hours per Week</b>	0	54.7%	<i>n</i> = 0
	1-10	9.5%	<i>n</i> = 5
	11-20	20.9%	<i>n</i> = 11
	21-30	7.6%	<i>n</i> = 4
	31-40	7.6%	<i>n</i> = 4
<b>Living Conditions</b>	Alone	15.1%	<i>n</i> = 8
	with Spouse/Partner	9.4%	<i>n</i> = 5
	with Parents/Family	7.5%	<i>n</i> = 4
	with Roommates	67.9%	<i>n</i> = 36

<b>Living Location</b>	On Campus	18.9%	<i>n</i> = 10
	Off Campus	81.1%	<i>n</i> = 43
<b>Marital Status</b>	Single/Never Married	94.3%	<i>n</i> = 50
	Married	3.8%	<i>n</i> = 2
	Divorced	1.9%	<i>n</i> = 1
<b>Income</b>	Less than \$19,000	75.5%	<i>n</i> = 40
	\$20,000-\$34,000	20.8%	<i>n</i> = 11
	\$35,000-\$69,000	3.8%	<i>n</i> = 2
	More than \$70,000	0%	<i>n</i> = 0
<b>Sexual Orientation</b>	Heterosexual	94.3%	<i>n</i> = 50
	Homosexual	1.9%	<i>n</i> = 1
	Bisexual	3.8%	<i>n</i> = 2
<b>Drink Type Preference</b>	Beer	47.2%	<i>n</i> = 25
	Mixed Drink	28.3%	<i>n</i> = 15
	Wine	9.4%	<i>n</i> = 5
	Hard Liquor	9.4%	<i>n</i> = 5
	Wine Cooler	1.9%	<i>n</i> = 1
	Liqueurs	1.9%	<i>n</i> = 1
	Champagne	1.9%	<i>n</i> = 1
	Fortified Wine	0%	<i>n</i> = 0
<b>Compensation Type</b>	Cash (\$15)	34%	<i>n</i> = 18
	SONA Course Participation Credit	66%	<i>n</i> = 35

Table 2.  
Correlation Matrix of Potential Covariates

	Mean	SD	Cold Liking	Cold Bias	Warm Liking	Warm Bias
AUDIT-C	5.13	1.93	.46**	.17	.04	-.16
ASRS	29.25	9.19	-.08	.07	-.24	-.02
EAT-26	8.52	5.42	-.20	.25	-.07	-.08
ColdTime	175.71	125.02	-.07	-.20	-.19	.02
WarmTime	145.83	103.73	-.11	-.10	-.18	-.12
Age	23.49	3.92	-.21	.04	-.27	-.10

*Note.* AUDIT-C = The Alcohol Use Disorder Identification Test-Consumption Scale. ASRS = Adult Self-Report Scale, (EAT-26<sup>©</sup>) = Eating Attitudes Test, ColdTime = Time taken in seconds to consume the cold beer, WarmTime = Time taken in seconds to consume the warm beer, Age = participants age at the time of the study, \*  $p < .05$ , \*\*  $p < .01$ .

Table 3.  
Preliminary Analyses among Cold Alcohol Liking and Cold Alcohol Attentional Bias

	Alcohol Liking	Alcohol Attentional Bias
Gender	$F(1, 50) = 5.71, p = .02$	$F(1, 49) = 0.56, p = .46$
(Male)	17.17 ( $SD = 4.47$ )	-2.20 ( $SD = 17.18$ )
(Female)	13.56 ( $SD = 6.12$ )	1.41 ( $SD = 13.12$ )
Compensation	$F(1, 50) = 0.92, p = .34$	$F(1, 49) = 0.40, p = .51$
(SONA)	15.57 ( $SD = 5.26$ )	-.047 ( $SD = 15.94$ )
(Paid)	17.06 ( $SD = 5.24$ )	-2.11 ( $SD = 16.34$ )
Drink Order	$F(1, 50) = 0.20, p = .66$	$F(1, 49) = 0.73, p = .40$
(Cold 1 <sup>st</sup> )	16.37 ( $SD = 5.67$ )	0.74 ( $SD = 12.38$ )
(Cold 2 <sup>nd</sup> )	15.72 ( $SD = 4.84$ )	-3.10 ( $SD = 19.33$ )
Cracker Order	$F(1, 50) = 0.01, p = .94$	$F(1, 49) = 1.31, p = .26$
(Cracker 1 1 <sup>st</sup> )	16.11 ( $SD = 5.60$ )	1.34 ( $SD = 14.41$ )
(Cracker 1 2 <sup>nd</sup> )	16.00 ( $SD = 4.97$ )	-3.78 ( $SD = 17.48$ )
DTP	$F(1, 45) = 0.46, p = .72$	$F(1, 44) = 3.31, p = .03$
(Beer)	17.17 ( $SD = 4.26$ )	-0.56 ( $SD = 15.56$ )
(Wine)	15.60 ( $SD = 6.50$ )	-18.28 ( $SD = 16.03$ )
(Mixed Drink)	15.27 ( $SD = 5.60$ )	4.89 ( $SD = 9.80$ )
(Hard Liquor)	15.60 ( $SD = 7.99$ )	1.44 ( $SD = 18.24$ )

Table 4.  
Preliminary Analyses among Warm Alcohol Liking and Warm Attentional Bias

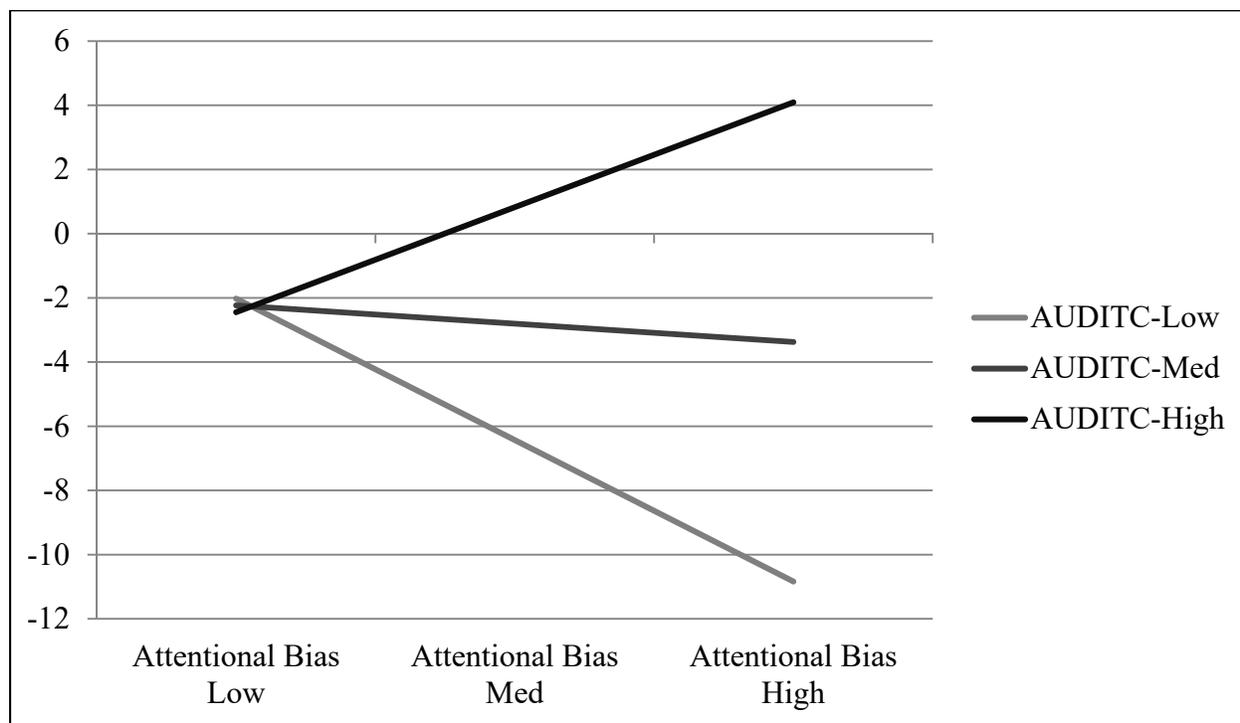
	Alcohol Liking	Alcohol Attentional Bias
Gender	$F(1, 50) = 0.14, p = .71$	$F(1, 49) = 2.12, p = .15$
(Male)	9.00 ( $SD = 4.24$ )	-4.25 ( $SD = 20.42$ )
(Female)	9.47 ( $SD = 4.26$ )	4.06 ( $SD = 14.95$ )
Compensation	$F(1, 50) = 14.82, p < .001$	$F(1, 49) = 0.08, p = .78$
(SONA)	7.71 ( $SD = 3.23$ )	-1.11 ( $SD = 19.01$ )
(Paid)	11.94 ( $SD = 4.71$ )	-2.71 ( $SD = 19.90$ )
Drink Order	$F(1, 50) = 0.11, p = .75$	$F(1, 49) = 1.08, p = .30$
(Cold 1 <sup>st</sup> )	8.96 ( $SD = 4.12$ )	.98 ( $SD = 14.83$ )
(Cold 2 <sup>nd</sup> )	9.35 ( $SD = 4.48$ )	-4.60 ( $SD = 23.01$ )
Cracker Order	$F(1, 50) = 0.15, p = .70$	$F(1, 49) = 0.34, p = .56$
(Cracker 1 1 <sup>st</sup> )	8.93 ( $SD = 4.31$ )	-3.13 ( $SD = 17.36$ )
(Cracker 1 2 <sup>nd</sup> )	9.38 ( $SD = 4.29$ )	.024 ( $SD = 21.19$ )
Drink Preference	$F(1, 45) = 0.40, p = .75$	$F(1, 44) = 1.60, p = .20$
(Beer)	9.72 ( $SD = 4.78$ )	-5.48 ( $SD = 15.60$ )
(Wine)	8.00 ( $SD = 5.10$ )	-0.86 ( $SD = 36.37$ )
(Mixed Drink)	9.13 ( $SD = 3.76$ )	4.19 ( $SD = 15.27$ )
(Hard Liquor)	7.80 ( $SD = 3.90$ )	-14.06 ( $SD = 13.67$ )

Table 5.  
Correlation Matrix of Main Variables

	Mean	SD	Cold Liking	Cold Craving	Cold Bias	Warm Liking	Warm Craving
Cold Liking	16.06	5.25	<b><math>\alpha = .95</math></b>				
Cold Craving	45.96	11.49	.47**	<b><math>\alpha = .81</math></b>			
Cold Bias	-1.06	15.97	-.03	-.04			
Warm Liking	9.15	4.26	.44**	.37**	-.12	<b><math>\alpha = .95</math></b>	
Warm Craving	43.62	12.60	.34*	.81**	.05	.47**	<b><math>\alpha = .86</math></b>
Warm Bias	-1.64	19.12	-.05	-.05	-.05	.03	.05

*Note.* Cronbach's alphas are provided on the diagonal. Cold/Warm Liking = liking following consumption of cold beer (range = 5 to 25) and warm beer (range = 5 to 19). Cold/Warm Craving = craving ratings assessed via the (DAQ) following consumption of cold beer (range = 20 to 77) or warm beer (range = 26 to 74). Cold/Warm Bias = alcohol attentional bias scores following consumption of cold beer (range = -40.78 to 36.03) or warm beer (range = -51.95 to 50.67), \*  $p < .05$ , \*\*  $p < .01$ .

Figure 1.  
Moderation of Alcohol Use Behavior on the Effect of Alcohol Liking on Alcohol Attentional Bias





UNIVERSITY OF  
ARKANSAS

Office of Research Compliance  
Institutional Review Board

January 12, 2017

MEMORANDUM

TO: David Lovett Carter Morrison  
Ryan Grant Meagan Linstrom  
Madelaine Mee Daniel Martin  
Lauren Hurd Alex Melkonian  
Kyle Jackson Lindsay Ham

FROM: Ro Windwalker  
IRB Coordinator

RE: PROJECT CONTINUATION

IRB Protocol #: 15-12-409

Protocol Title: *Reactions and Perceptions to Alcohol and Food*

Review Type:  EXEMPT  EXPEDITED  FULL IRB

Previous Approval Period: Start Date: 01/12/2016 Expiration Date: 01/12/2017

New Expiration Date: 01/12/2018

Your request to extend the referenced protocol has been approved by the IRB. If at the end of this period you wish to continue the project, you must submit a request using the form *Continuing Review for IRB Approved Projects*, prior to the expiration date. Failure to obtain approval for a continuation on or prior to this new expiration date will result in termination of the protocol and you will be required to submit a new protocol to the IRB before continuing the project. Data collected past the protocol expiration date may need to be eliminated from the dataset should you wish to publish. Only data collected under a currently approved protocol can be certified by the IRB for any purpose.

**This protocol is closed to enrollment.** If you wish to make *any* modifications in the approved protocol, including enrolling more participants, you must seek approval *prior to* implementing those changes. All modifications should be requested in writing (email is acceptable) and must provide sufficient detail to assess the impact of the change.

If you have questions or need any assistance from the IRB, please contact me at 109 MLKG Building, 5-2208, or [irb@uark.edu](mailto:irb@uark.edu).