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# Environmental Context Effects on Impulsivity and Subjective Craving in Caffeinated Alcohol Users

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# ENVIRONMENTAL CONTEXT EFFECTS ON IMPULSIVITY AND SUBJECTIVE CRAVING IN CAFFEINATED ALCOHOL USERS

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## ABSTRACT

ENVIRONMENTAL CONTEXT EFFECTS ON IMPULSIVITY AND SUBJECTIVE CRAVING IN CAFFEINATED ALCOHOL USERS

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Caffeinated alcohol beverages (CAB) (e.g., vodka and Red Bull, rum and Coke) have become increasingly popular among young drinkers. Research indicates that consumption of caffeinated alcohol is associated with higher reports of injuries requiring medical attention, engaging in more risky behaviors, and achieving greater levels of intoxication. As such, consumers of CAB are a population that may be at a higher risk of experiencing alcohol-related harms. Although CAB drinkers have been shown to exhibit more impulsive behavior, little research has examined impulse control in this population or other mechanisms that may contribute to alcohol-related risks for these individuals. It has been suggested that environmental cues may trigger craving and drinking through the influence on impulsivity. Thus, a bar context may elicit greater impulsivity, which in turn, increases one's craving for alcohol or CAB. Consequently, the present study sought: (1) to determine the influence of an environmental context (i.e., bar simulated lab) on subjective ratings of craving (i.e., alcohol craving, CAB-specific craving), and (2) to examine behavioral impulsivity as a mediator of the influence of environmental context on subjective cravings in a sample of moderate to heavy drinkers that consume CAB. Participants were 135 (66.7% female) college CAB drinkers. Using a between-subjects design, participants were randomized into either the experimental (i.e., simulated bar) condition or control (i.e., neutral context) condition and completed measures of alcohol use, CAB use, trait impulsivity, state impulsivity, and subjective craving for alcohol and CAB.

Findings revealed that participants in the experimental condition, as compared to those in the neutral condition, reported more subjective craving for alcohol, but not for CAB. The association between environmental context and subjective craving for alcohol was not mediated by state-level changes in impulsivity. Trait impulsivity was positively associated with alcohol and CAB craving at each time point, in both conditions. Therefore, the current investigation suggests that consumers of CAB may be sensitive to alcohol-related cues as indicated by greater responses in alcohol craving. However, state impulsivity did not explain this association. Future research may benefit from examining other potential mechanisms that explain the relationship between context and craving among CAB consumers.

This thesis is dedicated to my husband, Marcus Stamates.

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# CHAPTER I

# INTRODUCTION

Hazardous drinking is widespread among college students in the United States (Hingson, Heeren, Winter, & Wechsler, 2005; Wechsler, Lee, Kuo, & Lee, 2000). One factor that may be contributing to risky alcohol use is the consumption of caffeinated alcohol beverages (CAB; e.g., vodka and Red Bull, rum and Coke). Negative alcohol-related consequences associated with CAB use have been reported, even after accounting for alcohol-only use (see Linden & Lau-Barraco, 2014 for review). As such, consumers of CAB may be a subpopulation of drinkers that have a higher likelihood of experiencing alcohol-related harms (e.g., Lau-Barraco, Milletich, & Linden, 2014). One potential explanation for this may be related to their sensitivity to alcohol-related cues, and specifically how these cues affect impulsivity and craving. Consequently, the present study aims to further our understanding of why consumers of CAB may be at risk for experiencing negative alcohol outcomes. We aim to achieve this by determining the influence of a drinking context on impulsivity among CAB users and how this subsequently influences subjective alcohol or CAB cravings.

## Caffeinated Alcohol Use

CAB use has become increasingly popular among college students (e.g., O'Brien, McCoy, Rhodes, Wagoner, & Wolfson, 2008) and adolescents (Kponee, Siegel, & Jernigan, 2014) over the past decade. Recent studies have estimated as much as 65% of college students have reported CAB consumption in the previous year and 75% report lifetime use (Berger, Fendrich, & Fuhrmann, 2013). CAB drinkers report drinking alcohol more frequently and in greater quantities, as compared to alcohol-only users (e.g.,

Mackillop et al., 2012; O'Brien et al., 2008; Woolsey, Waigandt, & Beck, 2010). The most commonly reported reasons for using these beverages include their enjoyable taste, they increase alertness, and they allow the drinker to stay up longer and achieve greater intoxication (Linden & Lau-Barraco, 2014). Given the recent popularity of CAB, especially among college students, a burgeoning literature has emerged on understanding factors and risks associated with the use of caffeinated alcohol (see Linden & Lau-Barraco, 2014 for review).

Research suggests these types of beverages may be contributing to risky drinking patterns and subsequent alcohol-related consequences, above and beyond consuming alcohol alone (e.g., Mackillop et al., 2012; Marczinski, 2011; O'Brien et al., 2008). Cross-sectional reports indicate that young adult drinkers are aware of the stimulant properties of CAB and choose this type of beverage because they believe it counteracts the sedative effects of alcohol (e.g., Marczinski, 2011). Experimental studies have supported that CAB use may reduce feelings of subjective intoxication (i.e., individuals report feeling less drunk), but have little impact on objective intoxication (e.g., Ferreira, de Mello, Pompeia, & de Souza-Formigoni, 2006; Marczinski & Fillmore, 2006). Specifically, Marczinski, Fillmore, Bardgett, & Howard (2011) found that when compared to alcohol alone, CAB use did not alter impairment on a behavioral control task, nor were any differences in breath alcohol concentrations observed between alcohol-only and CAB conditions. However, lower subjective feelings of mental fatigue and higher feelings of stimulation were reported in the CAB condition, as compared to the alcohol-only condition. Another experiment yielded similar results (Marczinski, Fillmore, Henges, Ramsey, & Young, 2013). Taken together, these findings suggest that

compared to alcohol-only users, consumers of CAB may drink in a higher-risk scenario. That is, CAB drinkers may be more likely to engage in risky behaviors (e.g., drive after drinking) because they subjectively feel less intoxicated than they actually are.

**Negative Alcohol-related Consequences.** There are a number of known negative consequences associated with CAB use. Although causal statements about whether CAB use leads to consequences cannot be made, studies indicate CAB use is generally associated with higher alcohol-related problems (Lau-Barraco et al., 2014). More specifically, studies have linked CAB use, as compared to alcohol-only use, with a higher likelihood of being physically injured (O'Brien et al., 2008), a higher risk of driving with someone intoxicated (Brache & Stockwell, 2011), and more frequent engagement in risky sexual behaviors (Snipes & Benotsch, 2013). Further, CAB users also are more likely to report other illicit substance use (Brache & Stockwell, 2011; Snipes & Benotsch, 2013). Interestingly, a 2010 field study by Thombs and colleagues examined 1,255 college student patrons as they were exiting venues in a local bar district. Their results revealed that compared to bar patrons who consumed only alcohol, those consuming CAB on that drinking occasion were at a three-fold increased risk of leaving the bar intoxicated and were four times more likely to intend on driving home. Although this finding could be attributed to the fact that CAB users also consumed more alcohol than their alcohol-only users, it does highlight CAB use as an important risk factor when targeting drinkers who may be at a higher likelihood to experience negative consequences.

It is important to note that not all research supports a positive association between CAB use and alcohol-related risks. Two studies found CAB use to be associated with

less alcohol consumption (de Haan, de Hann, van der Palen, Olivier, & Verster, 2012; Woolsey et al., 2010) and fewer negative consequences (de Haan et al., 2012). Some studies have found no association between CAB use and alcohol-related problems (e.g., Alford, Hamiltion-Morris, & Verster, 2012; Peacock, Bruno, Martin, & Carr, 2013). These findings may be a result of using within-subjects designs, whereby participants are asked to recall consumption on CAB drinking occasions and non-CAB drinking occasions (e.g., de Haan et al., 2012; Woosley et al, 2010). Thus, concerns with this design include the participants' ability to accurately report their consumption and to differentiate these two types of drinking occasions. Despite these study results, however, there is evidence to warrant the study of CAB users as an important sub-population of drinkers, as they may be at a greater risk of experiencing alcohol-related harm. Furthermore, due to the inconsistent findings regarding the risks related to CAB use in the aforementioned studies, further research is needed to understand CAB use and to explore why CAB use may be linked to risky behaviors. It is possible that CAB drinking habits are related to one's impulsivity, but limited research has examined these constructs and fewer have used an experimental design.

**Impulsivity**

Although impulsivity has been studied extensively in the alcohol literature (see Dick et al., 2010 for review) and linked to greater alcohol misuse (see Sher, Trull, Bartholow, & Vieth, 1999 for review; Ryb, Dischinger, Kufera, & Read, 2006), only a few studies have examined its relation to CAB use (Amlung, Few, Howland, Rohsenow, Metrik, & Mackillop., 2013; Brache & Stockwell, 2011; Heinz, de Wit, Lilje, & Kassel, 2013; Watson, Sweeney, & Louis, 2014). A recent review by Verster and colleagues

(2012) argued that individuals who consume caffeinated alcohol may be more likely to display impulsive personality traits and engage in risk-taking behaviors in general. Thus, alcohol-related harms experienced may be due to characteristics of the drinker, rather than CAB use itself. Subsequently, studies have sought to further explore associations between impulsivity and CAB use (Amlung et al., 2013; Heinz et al., 2013; Watson et al., 2014). However, findings from these reports are mixed, as some research supports a positive relationship between some measures of impulsivity (e.g., self-report) and CAB use (e.g., Brache & Stockwell, 2011; Heinz et al., 2013), whereas other measures of impulsivity (e.g., delayed reward discounting task) are unrelated to CAB use (e.g., Amlung et al., 2013). As such, the existing literature has not addressed the relationship between impulsivity and CAB use fully. Impulsivity could be an important construct to explore in consumers of CAB because it may be one potential reason why these drinkers report risky behaviors related to alcohol. Because impulsivity is an indicator of deficient behavioral control (Fillmore, 2003), a deeper understanding of this concept can be gained from behavioral control theories.

**A Two-Process Model of Behavioral Control**. According to behavioral control theories, there are two distinct processes that control one's behavior, which include activation (or "go" process) and inhibition (or "stop" process) mechanisms (e.g., Clay, Allen, & Parran, 2008; Gray, 1977). These two opposite processes are constantly competing against each other, and "the relative strength of each determine behavioral control" (Howard & Marczinski, 2010). Inhibition processes help regulate behavior or allow one to withhold or suppress a response (Fillmore, 2003). Thus, if the inhibition mechanism dominates over the activation mechanism within the behavioral control

model, then the response is successfully suppressed. However, if activation dominates, then this failure in the inhibition process can lead to an impulsive or inappropriate response (e.g., Fillmore, 2003; Howard & Marczinski, 2010).

Impulsivity is conceptualized as a multidimensional concept that includes a wide array of constructs related to either one's personality (i.e., trait impulsivity), or one's behavioral impulsivity (i.e., state impulsivity; Dick et al., 2010). It is broadly defined as one's tendency to act without considering future consequences and an inability to inhibit a response (e.g., Dawe, Gullo, & Loxton, 2004; Reynolds, Ortengren, Richards, & de Wit, 2006). Thus, according to behavioral control theory, impulsive individuals would be expected to display more failures in the inhibition process on a behavioral control task. Perhaps CAB drinkers display a deficit in their inhibition process, in which they are less able to control their behavior (i.e., display deficient behavioral control), and this may be particularly relevant in drinking-related contexts. That is, the inhibition process could be influenced by the environment or context, such that when a drinker is presented with alcohol-related cues, they also display more impulsive responses. Consequently, this elicited impulsive response may lead to a motivation (i.e., craving) to consume alcohol. Thus far, research has yet to examine these concepts experimentally to address how consumers of CAB behaviorally respond in a simulated drinking context.

**Impulsivity and CAB use.** We are aware of only four studies that have directly examined various facets of impulsivity and their relation to CAB use. The first two studies examined relationships between typical CAB use and aspects of trait impulsivity. First, Heinz and colleagues (2013) conducted an experiment to examine expectancy effects of mixing alcohol with caffeine. Their baseline correlational analyses revealed a

positive association between typical quantity and frequency of CAB use and impulsivity, such that individuals who reported more CAB use also reported higher levels of trait impulsivity. Second, a cross-sectional study by Brache and Stockwell (2011) examined the relationship between CAB use, heavy drinking, and negative consequences, while controlling for risk-taking tendency. Risk-taking tendency in this study was defined as a preference for thrill-seeking and adventurous behavior that directly affects one's physical health and safety. Their findings revealed that CAB use was related to more heavy drinking, and CAB consumers were twice as likely to experience negative consequences, above the influence of risk-taking tendency. Furthermore, they found that CAB use during the past 30 days was associated with greater odds of reporting higher risk-taking in general. Brache and Stockwell (2011) concluded that CAB consumption itself can increase one's risk for experiencing alcohol-related consequences. However, the authors note that two limitations of this study included that their modified measure of risk-taking had low internal consistency and that they did not use a behavioral impulsivity measure. As such, future research testing these relationships with a more validated measure of impulsivity/risk-taking would offer more conclusive support for the association between CAB use and alcohol-related consequences.

To expand on previous findings regarding trait impulsivity, two additional studies experimentally tested impulsivity and its relationship to CAB use. Consistent with the Heinz study, Amlung et al. (2013) found a positive association between CAB drinking frequency and trait impulsivity, such that more frequent CAB use was associated with higher trait impulsivity. Furthermore, they found that CAB drinking frequency was associated with alcohol misuse, even after controlling for both trait and state impulsivity.

Interestingly, partial correlations revealed significant relationships between CAB use and trait impulsivity, but no association between CAB use and state impulsivity (i.e., a questionnaire-based measure of delayed reward discounting). As such, it appears that some measures of impulsivity may be sensitive to CAB use, whereas others are not. However, there are limitations to this study. Specifically, typical alcohol use was not controlled for, and the authors made no comparisons between alcohol-only and CAB users on impulsivity or alcohol misuse. Thus, the authors' findings are limited when concluding that CAB use is riskier than alcohol-only use. Additionally, the authors used a questionnaire-based impulsivity task using a hypothetical scenario, rather than an objective performance-based task to measure impulsivity. Given the limited research on the relationship between CAB use and state impulsivity, it is plausible that different results may be found using other validated behavioral measures of impulsivity. The present study sought to address these limitations by examining performance on a behavioral control task while controlling for typical alcohol use.

A second, more recent laboratory-based study expanded the CAB literature by examining neurocognitive (i.e., event-related potentials) and impulsivity correlates of drinking behaviors including CAB use. Watson et al. (2014) compared 14 CAB and 46 non-CAB drinkers on several aspects of impulsivity, which included measures of trait impulsivity, sensation seeking (i.e., a need for stimulation/low tolerance for boredom; Zuckerman, 1974), and drinking-induced disinhibition (i.e., impulsive behaviors/experiences displayed while intoxicated). Results indicated that when in a laboratory-based setting, CAB drinkers reported higher levels of sensation seeking and drinking-induced disinhibition as compared to non-CAB drinkers. However, no

significant differences were observed in trait impulsivity between groups, which may have been due to the relatively small sample size (14 CAB users versus 46 non-users).

Overall, the results of studies on the link between impulsivity and CAB use highlight the multifaceted nature of impulsivity. Some research supports that aspects of impulsivity are related to CAB use (e.g., self-report measures of trait impulsivity; Amlung et al., 2013; Brache & Stockwell, 2011; Heinz et al., 2013), whereas other objective measures, such as the questionnaire-based delayed reward discounting task, have been shown to be unrelated to CAB use (e.g., Amlung et al., 2013). Although some of these constructs have been examined and discussed in the aforementioned studies, research on exploring behaviors related to both trait and state impulsivity in CAB drinkers are limited. Moreover, not all of these studies controlled for typical alcohol use. Thus, it is unclear in the current literature whether CAB use itself is influencing consumers to engage in risky behaviors, or perhaps risks associated with CAB use are related to personality or behavioral characteristics of the consumer instead. Given the lack of research on this topic as well as the inconsistencies in prior studies on this topic, additional research that addresses both trait and state impulsivity while controlling for typical alcohol use is needed to help characterize these associations more clearly.

**Measurement of Impulsivity**. Several instruments have been developed to measure various constructs of impulsivity, including trait and state impulsivity. Each construct is assessed using different types of instruments. *Trait impulsivity*, theorized as relatively stable over time, is assessed typically using self-report measures, such as the UPPS-P Impulsive Behavior Scale and the Barratt Impulsiveness Scale-11 (Dick et al., 2010). *State impulsivity* is often assessed using laboratory-based behavioral tasks. These

tasks objectively assess one's level of impulsivity, typically by measuring an individual's reaction times and accuracy. Unlike self-report measures of impulsivity, performance on these behavioral tasks is not stable across time, as scores can be affected by alcohol consumption and other influential cognitive factors (see Fillmore, 2003). There are performance-based behavioral tasks developed to measure behavioral control. An indicator of a lack of behavioral control is response inhibition (i.e., the ability to withhold a response; also referred to as inhibitory control; see Perry & Carroll, 2008 for review). According to behavioral control theories, the inhibitory dimension of behavioral control serves to regulate behavior (e.g., Dick et al., 2010; Henges & Marczinski, 2012). Thus, failures in the inhibitory dimension of behavioral control can lead to impulsive actions (Fillmore, 2003).

One of the most reliable and sensitive performance-based measures of task impulsivity is the cued go no-go task (Marczinski & Fillmore, 2003; Miller, Schaffer & Hackley, 1991). This task measures behavioral control by assessing one's ability to inhibit an instigated (i.e., environmentally-triggered) response (e.g., Dick et al., 2010; Henges & Marczinski, 2012). More specifically, this task implements preliminary cues that determine whether one should quickly execute a response (measuring the "go" or activation process) or suddenly inhibit a response (measuring the "stop" or inhibition process) to subsequently displayed signals (known as targets). Figure 1 illustrates a typical sequence of trials displayed in a cued go no-go task. To explain further, an initial "go" or "no-go" cue is presented before an actual go or no-go target is shown. The cue-target relationship is manipulated, whereby cues have an 80% probability of correctly signaling a target (i.e., a valid cue) and a 20% probability of incorrectly signaling the

target (i.e., invalid cue; Howard & Marczinski, 2010). As such, the cue facilitates the execution or suppression of a response because of the preparatory processing the initial cue provides. For example, participants quickly learn the cue-target relationship, so once a valid cue appears (i.e., go target is preceded by a go cue), responses are faster (Miller et al., 1991). However, when the cue incorrectly predicts the target, response execution or inhibition is more difficult because the participant must switch processes (Marczinski & Fillmore, 2003). Reaction times and accuracy are recorded on both go and no-go trials. Increased impulsivity, or a loss of inhibitory control, is observed on trials when individuals fail to suppress a response when a no-go target is presented (Perry & Carroll, 2008).

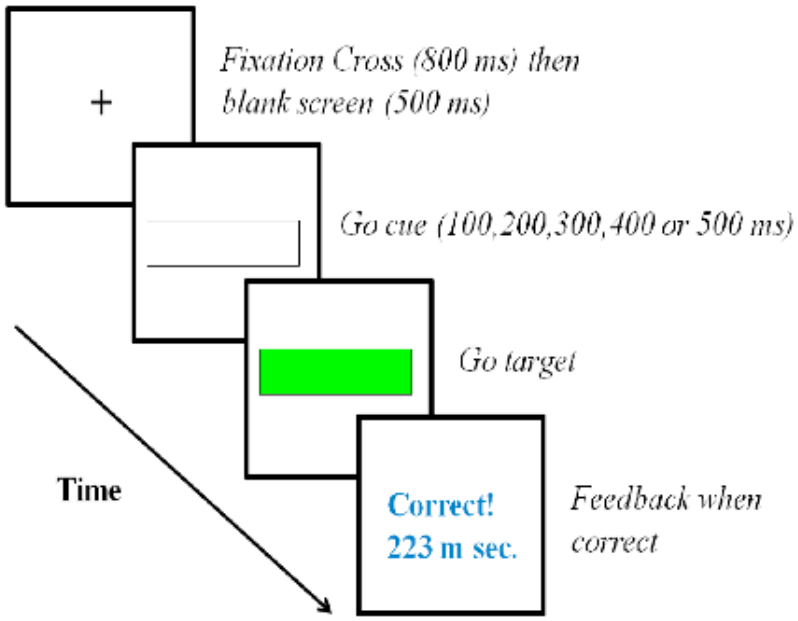


*Figure 1*

This figure illustrates a typical trial sequence in the valid go cue condition on a cued go no-go task. Adapted from "Drug abuse as a problem of impaired control: current approaches and findings," by M. T. Fillmore, 2003, *Behavioral & Cognitive Neuroscience Reviews, 2,* 179-197.

**Alcohol-related Cues and Impulsivity**

Prior research has shown that impulsivity may be influenced by the presence of alcohol-related cues. Broadly, studies have shown that drinkers tend to display poorer behavioral control (i.e., more impulsive actions) when presented with alcohol-related stimuli, be it visual or olfactory cues. More specifically, Noel and researchers (2007) compared forty detoxified alcoholics and forty healthy controls on a modified go no-go task, whereby shapes and figures were replaced with alcohol-related and neutral words. Their results revealed alcoholics displayed poorer inhibitory control (i.e., made more errors) than controls when alcohol-related stimuli had to be detected. Gauggel and colleagues (2010) divided 20 detoxified alcohol-dependent participants into alcohol cue and water cue exposure groups. Participants in the alcohol cue group were asked to smell alcohol before completing a stop-signal behavioral control task, whereas the control group was asked to smell a glass of water. Their findings indicated participants who smelled alcohol were impaired during their performance on a stop signal task, as compared to the water cue exposure group. Weafer and Fillmore (2012) used a modified go/ no-go task in which alcohol images were integrated and used in a sample of adult drinkers. Response inhibition was significantly poorer following alcohol images as compared to neutral images, meaning participants responded to alcohol images when they should have suppressed their response. Nikolaou, Field, and Duka (2013) also used alcohol-related stimuli and found alcohol images impaired inhibitory control in their sample of social drinkers. Taken together, these experimental findings suggest drinkers may experience an arousal response when presented with alcohol-related cues, such that inhibiting behavior becomes more difficult.

Although research suggests alcohol-related primes, such as alcohol-related words, images, and olfactory cues, elicit greater impulsivity, only one study was found to test the influence of environmental cues (i.e., a bar-simulated context) on subsequent impulsive behaviors. Jones, Rose, Cole, & Field (2013) measured craving, performance on a stop-signal task (a behavioral measure of impulsivity), and ad-lib alcohol consumption in a group of social drinkers. Participants were divided into two groups in which they were exposed to either alcohol cues in a bar simulated environment or to water cues in a neutral context. Their results indicated that level of craving was positively associated with impulsivity following the alcohol cue exposure. However, surprisingly, they did not observe differences in impulsivity between their group conditions. The authors suggested three reasons for their findings. First, perhaps these results may be attributed to their sample, as their participants may not have been heavy drinkers. Second, their cue exposure was presented before but not during the stop-signal task. As such, it may be that the exposure effects did not last long, unlike Weafer and Fillmore (2012), who implemented alcohol cues throughout their task. And third, the authors did not collect baseline performance on the stop-signal tasks. Thus, the authors suggested future studies should collect a baseline measure of inhibitory control to assess before and after cue exposure changes.

In sum, research generally supports that alcohol-related cues elicits greater impulsive responses. However, cue exposure effects have not been studied in CAB drinkers. It may be that, similar to studies of alcohol-only use, that CAB users display impulsive behaviors because they have a greater arousal response during alcohol cue exposure. That is, an alcohol-related context may elicit greater impulsivity, and in turn,

determine one's alcohol craving. Given that cue exposure has only been tested in alcohol-only drinkers, an examination of cue effects in consumers of CAB may provide insight as to why these individuals have been shown to engage in greater drinking and risky behaviors.

## Craving

**Environmental Context Influence on Craving.** It is possible that alcohol-related cues elicit state level changes in impulsivity, which in turn impacts one's craving for alcohol. In general, craving refers to one's "central state" of desire to take a substance (e.g., Rankin, Hodgson, and Stockwell, 1979). It has been shown that exposure to alcohol-related stimuli can trigger craving (see Litt & Cooney, 1999 for review). One potential explanation for this is offered by the incentive-sensitization theory. This theory aims to explain how cues can trigger incentive motivation for drug use, which ultimately leads to drug seeking and taking behaviors (Robinson & Berridge, 1993; 2001). From this theoretical standpoint, a drinker's brain systems, specifically involved in processes of motivation and reward, can become sensitized, or rendered "hypersensitive" to drugs and related stimuli. In other words, through classical conditioning, a drinker can become more sensitive when presented with alcohol-related stimuli. As a result, these now sensitized brain systems mediate the incentive salience, or wanting, and subsequent drug seeking and drug taking behaviors. That is, a drinker associates these alcohol-related stimuli with incentive properties (i.e., positive reinforcers), and subsequently increases their motivation (i.e., craving) to consume alcohol. Laboratory studies have well-established a link between self-reported craving and subsequent ad libitum drinking (e.g.,

Christiansen, Rose, Cole & Field, 2012; Schulze & Jones, 2000; Walitzer & Sher, 1990), such that those who report higher craving for alcohol also consume more alcohol.

Numerous studies have been conducted whereby an alcohol beverage (e.g., Heinz et al., 2013; Marczinski, Fillmore, Henges, Ramsey, & Young, 2013), alcohol-related cue (e.g., McCusker & Brown, 1990; Schulze & Jones, 2000), or alcohol-related context (e.g., Jones et al., 2013) have been used to elicit subjective alcohol craving. Although most of this research has been conducted in alcohol dependents (e.g., Fox, Bergquist, Hong, & Sinha, 2007; Laberg, 1986), there are studies to suggest alcohol cues elicit responses of subjective craving in nondependent drinkers (e.g., Christiansen et al., 2012; Greeley, Swift, Prescott, & Heather, 1993; McCusker & Brown, 1990). For example, a study compared heavy and light drinkers on their subjective craving responses pre- and post-exposure to water versus alcohol cues (Papachristou, Nederkoom, Havermans, van der Horst, & Jansen, 2012a). Their results revealed a significant main effect of alcohol cue exposure on craving, as compared to water exposure. That is, craving for alcohol increased after being presented with the alcohol cue. Although their heavier drinkers overall reported higher levels of craving, heavy and light drinkers craving increased equally after alcohol cue exposure. Considering these findings, it appears that alcohol cues are important factors in determining one's alcohol craving.

There are studies indicating the influence of alcohol cues on craving, but the role of environmental context specifically has been less studied experimentally. However, in general, there is research to support that environmental context may impact one's craving for alcohol. For example, Jones et al., (2013) examined responses of subjective craving in participants who were exposed to either a simulated bar environment or a neutral

laboratory. They found that participants reported greater subjective craving for alcohol in the simulated bar environment than participants in the neutral laboratory condition. Further, Bordnick and colleagues (2008) examined the effects of various neutral (e.g., a kitchen) and alcohol-related (e.g., bar, party) virtual reality programs on subjective reports of craving. Their findings also revealed subjective alcohol craving significantly increased during exposure to alcohol-related cue environments, as compared to their neutral cue environments. Taken together, these findings suggest environmental cues can trigger craving or motivation to consume alcohol. However, the influence of an environmental context on craving has not been examined in consumers of CAB. The relationship between drinking context and craving may be of particular importance for CAB drinkers, as studies have shown CABs are more typically consumed in public venues (i.e., bars, nightclubs; Peacock, Bruno, and Martin, 2013), rather than in private residences. Perhaps consumers of CAB experience more craving for CAB in alcohol-related contexts (i.e., CAB craving). As such, research on the effects of environmental context on craving (alcohol and CAB craving) may provide insight into behaviors displayed by these at-risk drinkers.

**Impulsivity and Craving.** It has been suggested that a combination, or interaction, of incentive-sensitization and impulse behaviors may play a role in addiction (Dawe et al., 2004). Thus, environmental cues may trigger alcohol craving through the mechanism of increased impulsivity. However, traditionally, impulsivity and craving have been studied as outcome variables in the addiction literature. Researchers have integrated these concepts and posited that individuals experience more craving due to their inability to control their urges (e.g., Doran, Spring, & McChargue, 2007).

There are studies that have examined the associations between different impulsivity dimensions and craving. For example, in Papachristou et al. (2012a), a comparison of heavy and light drinkers revealed that heavy drinkers with deficit response inhibition on a stop signal task also displayed more cue-elicited craving during alcohol exposure. A similar study by this group (2012b) indicated that perceived availability of alcohol in combination with impaired response inhibition moderated cue-elicited craving in their sample of light to moderate drinkers. However, a relationship between response inhibition and craving was not found, which the authors attributed to the low drinking status of their sample. And last, Joos et al. (2013) measured various dimensions of impulsivity and different forms of craving in a sample of abstinent alcohol-dependents. The authors reported positive associations between self-reported impulsivity, emotional craving, and reflection impulsivity (gathering and evaluating information before making a decision) on an information sampling task. The findings from these studies provide support that various aspects of these concepts might simultaneously reinforce drinking behavior. As such, their relationship may be particularly important in understanding the development of alcohol problems.

**The Current Study**

The purpose of the present study was to test the impact of the environment on alcohol and CAB cravings through its influence on behavioral control among a sample of CAB drinkers. As already noted, prior research indicates alcohol-related cues can increase one's impulsivity (e.g., Noel et al., 2007; Weafer & Fillmore, 2012) and craving for alcohol (e.g., Jones et al., 2013; Marczinski et al., 2013). Based on incentive-sensitization theory, it may be that context impacts craving for alcohol use in general, or

CAB use specifically, through influencing one's association of alcohol-related stimuli with positive reinforcers (i.e., incentive properties). This, in combination with poorer behavioral control (i.e., greater impulsivity), may lead to a heightened craving response. These relationships could potentially explain one reason why consumers of CAB have been shown to engage in heavy drinking and experience negative drinking consequences. Consequently, the present study sought to understand the effects of an alcohol context on impulsivity and craving in a sample of moderate to heavy drinkers that CAB. Using a between-subjects design, participants were randomly assigned to either a simulated bar (i.e., experimental condition) or neutral context (i.e., control condition). Participants were administered a behavioral control task and provided subjective cravings for alcohol and CABs. It was expected that exposure to a simulated bar context would influence one's impulsivity. In turn, impulsivity was expected to predict both alcohol and CAB craving.

Specific study aims and hypotheses are as follows:

**Aim 1:** To experimentally test the influence of environmental context (i.e., simulated bar, neutral context) on subjective craving for alcohol and CAB.

*Hypothesis 1:* Research has shown the importance of context on one's drinking behavior (Jones et al., 2013) and that alcohol-related cues can elicit responses of craving (e.g., Joos et al., 2013; Papachristou et al., 2012). However, craving responses in consumers of CAB have not been examined. Given that drinkers are more likely to consume CAB in nightclub/bar settings (Peacock et al., 2013), it was expected that the simulated bar context, as compared to the neutral context, would hold incentive motivational properties, which in turn would elicit subjective craving responses. Thus,

participants in the experimental condition were expected to report greater craving responses for alcohol and CAB, as compared to participants in the control condition. Baseline craving and typical alcohol use were added as controls.

**Aim 2:** To examine impulsivity as a mediator explaining the association between environmental context and subjective craving for alcohol and CAB (see Figure 2).

*Hypothesis 2:* Researchers have posited that individuals experience more craving due to their impulsivity (e.g., Doran et al., 2007). Further, research has supported this theory by indicating measures of *state impulsivity* (i.e., inhibitory control) and craving are associated (Papachristou et al., 2012a). It is hypothesized that *state impulsivity* would mediate the influence of environmental context on alcohol and CAB craving. Specifically, it was expected that the experimental context would elicit greater impulsivity, which in turn, would increase craving for alcohol and CAB. Typical alcohol use and trait impulsivity were added as controls.

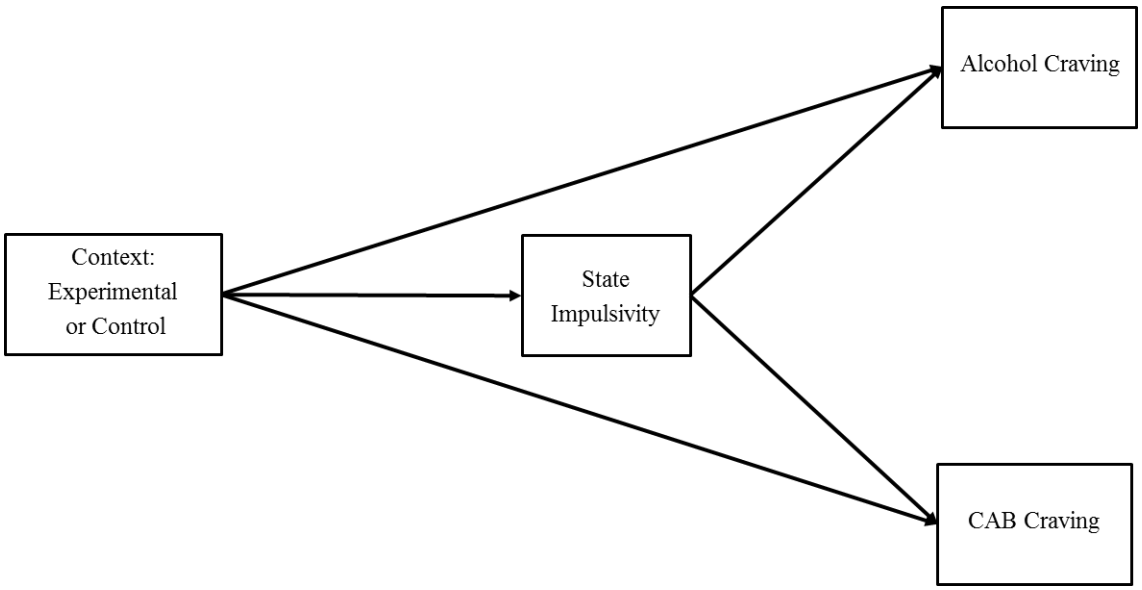


*Figure 2*

Aim 2 is to test state impulsivity as a mediator explaining the association between context condition (experimental or control) and craving for alcohol and CAB. Direct paths in the model are between (1) context condition and alcohol craving and (2) context condition and CAB craving. Indirect paths include (1) context to state impulsivity to alcohol craving and (2) context to state impulsivity to CAB craving. Control variables include trait impulsivity, typical alcohol use, and baseline craving for alcohol and CAB, which were included in the analysis but omitted from the figure for clarity.

# CHAPTER II

# METHOD

## Participants and Recruitment

To be eligible, participants must have (1) been between 18 and 25 years old, (2) consumed any caffeinated alcohol in the past 30 days, (3) no history of seizures, and (4) normal color vision, and normal/corrected-to-normal vision. Based on a medium effect size found in previous alcohol cue-reactivity literature (e.g., see Carter & Tiffany, 1999 for meta-analysis; Jones et al., 2013; Kambouropoulos & Staiger, 2001; Weafer & Fillmore, 2012), G*Power (Faul, Erdfelder, Lang, & Buchner, 2007) estimated, using a medium effect size for an analysis of covariance (ANCOVA), that approximately 128 participants were needed for the current study. Regarding path analysis, Kline (2011) states the best estimate for power is 20:1, such that the sample size is at least 20 subjects for each parameter. In this study, there are seven parameters, and therefore 20 X 7 would indicate a sample size of at least 140 participants would be needed. As such, one hundred and fifty-five undergraduate students at Old Dominion University (ODU) participated in the present study. Although no participant indicated the true hypothesis of the study, 15 participants' qualitative responses speculated that the context exposure specifically was aimed to influence their responses, and thus were removed from all analyses. Thus, the present study approximately had a 91.0% deception rate that is consistent with prior alcohol experiments (e.g., Berstein, Wood, & Colby, 2016). Additionally, four participants did not meet the age requirement and were removed from all analyses. One person was removed from analyses because they scored less than 50% accuracy on the

cued go/no-go task. The final sample consisted of 135 participants who were randomly assigned to either control (*N* = 65) or experimental (*N* = 70) condition. Of the total sample, the majority of participants were female (*N* = 90; 66.7%). The average age was 19.36 (*SD* = 1.68) years. The sample was comprised of 57.8% freshmen, 20.7% sophomores, 11.1% juniors, and 10.4% seniors. Sample ethnicity was 45.2% Caucasian, 37.0% African American, 9.6% Hispanic, 5.2% Asian, and 3.0% "Other." Participants reported consuming an average of 9.76 (*SD* = 8.71) alcohol-only drinks per week and 5.84 (*SD* = 5.73) CABs per week.

**Procedure**

Data collection was administered in-person, using a between-subjects design. After signing up for a time online via SONA systems, participants were randomly assigned to either the bar context condition or the neutral context condition. The bar context was simulated to resemble a typical bar, including a bar with stools, alcohol advertising signs, shelves of liquor bottles, and a dart board. To further simulate the bar context, bottles containing nonalcoholic beer were opened to provide the scent of alcohol and were hidden from participants. The neutral context was an empty teaching room containing a table, chair, and computer. Participants were told to meet the researcher in an office in the main Psychology building and were tested in groups of three. Undergraduate research assistants were used as confederates if all participants were not present. Upon arrival, participants were oriented to the study procedure (see Table 1 for overview of study procedures). Participants were then provide informed consent and completed a baseline battery of measures (see Measures). Following completion of baseline measures, participants were taken to their designated laboratory (either the bar or

neutral context) and seated in front of a laptop computer. Instructions on how to complete the computer task were provided. After this, participants completed the cued go/no-go task on the laptop computer. The task took approximately 25 minutes to complete and included four one-minute breaks. Upon completion of this task, participants completed the same craving questionnaire as was administered at baseline. The entire study took approximately 1 hour. All measures and procedures were reviewed and approved by ODU's Institutional Review Board and followed APA guidelines (APA, 2002).

**Evaluation of Deception.** Following the last questionnaires, participants completed an open-ended questionnaire about their beliefs on the study's purpose (see Appendix F). Participants with any response indicating that the purpose of the study was related to alcohol stimuli, or impulsivity specifically, were removed from further analyses.

**Debriefing.** Following the deception assessment, participants were debriefed and awarded course credit for their time. Participants were e-mailed a debriefing form (see Appendix G) through SONA, which included information about the purpose of the study, contact information for the ODU Counseling Center, and the researcher's contact information. Participants were asked not to discuss the study with anyone to protect the integrity of the study.

Table 1

*Sequence of Battery and Procedures*

| Order | Task | Time (min) |
|---|---|---|
| **1** | **Introduction**<br>Study Orientation<br>Instructions | **5** |
| **2** | **Baseline Battery**<br>Notification Statement<br>Demographics Questionnaire<br>Daily Drinking Questionnaire – Alcohol<br>Daily Drinking Questionnaire – CAB use<br>Barratt Impulsiveness Scale –version 11<br>Alcohol Urge Questionnaires – Time 1 | **15** |
| **3** | **Moved to bar or neutral context** | **3** |
| **4** | **Cued Go/No-go Task** | **25** |
| **5** | **Alcohol Urge Questionnaires – Time 2** | **3** |
| **6** | **Deception Assessment** | **2** |
| **7** | **Debriefing** | **5** |
| | Estimated total time = | **58** |

## Measures

**Demographics.** Participants reported their general background including age, gender, ethnicity, and class standing.

**Alcohol and caffeinated alcohol use.** Participants' typical alcohol and caffeinated alcohol consumption were measured using the Daily Drinking Questionnaire (DDQ; Collins, Parks, & Marlatt, 1985). Participants reported the number of alcoholic drinks (not including caffeinated alcohol) and the number of caffeinated alcoholic drinks (e.g., Red Bull and vodka, rum and Coke, etc.) they typically consume for each day of a typical week over the past three months. The DDQ has adequate internal consistency ($\alpha$ = .78, Geisner, Larimer, & Neighbors, 2004) and has been widely used for drinking assessment in the alcohol literature (e.g., Lau-Barraco & Linden, 2014; Morean & Corbin, 2008; Mallett, Bachrach, & Turrisi, 2008). The DDQ has been adapted to assess CAB use in prior studies (e.g., Lau-Barraco & Linden, 2014; Lau-Barraco et al., 2014).

To measure typical alcohol use, several variables were calculated from the DDQ. These included drinking quantity (the total number of drinks consumed in a typical week), drinking frequency (the total number of days alcohol was consumed in a typical week), as well as frequency of binge drinking (four or more drinks/occasion for women; five or more drinks/occasion for men) in a typical week. All of these items are reported as descriptive information of the sample (see Table 2). Drinking quantity for alcohol was used as a control for all hypothesis testing.

To measure typical CAB use, quantity was calculated by summing the total number of CAB drinks consumed in a typical week. CAB drinking frequency was

calculated by summing the total number of days drinking occurred in a typical week. Frequency of CAB binge consumption was calculated as the number of days in a typical week in which four or more CAB drinks were consumed by women/five or more CAB drinks consumed by men. These CAB use items are reported in the descriptive statistics for the sample (see Table 2).

**Trait impulsivity**. The Barratt Impulsiveness Scale – version 11 (BIS-11; Patton, Stanford, & Barratt, 1995) was used to assess trait impulsivity. The measure includes 30 statements scored from 1-4 on a scale from *rarely* to *always.* A total score is also summed with higher scores indicating a higher level of impulsivity. This measure has adequate test-retest reliability, adequate criterion validity, and internal consistency coefficients for the BIS-11 total score to range from .79 to .83. The present study's internal consistency was .73.

**State impulsivity.** To measure impulsivity on a behavioral task, participants completed the cued go/no-go reaction time task (Marczinski & Fillmore, 2003, 2005) operated on a laptop computer using E-Prime experiment generation software (Schneider, Eschman, & Zuccolotto, 2002). A trial involved the following sequence of events: (1) a fixation point (+) was presented for 800 ms; (2) a blank white screen was presented for 500 ms; (3) a cue was displayed for one of five stimulus onset asynchronies (SOAs were 100, 200, 300, 400, and 500 ms); (4) a go or no-go target, remained visible until a response occurs or 1,000 ms has elapsed; and (5) an intertrial interval of 700 ms.

The cue was a rectangle presented in either horizontal or vertical orientation in the center of the computer monitor against a white background. The go target was the color green, and the no-go target was blue, which are presented in hues that are easily

distinguishable by all participants. Participants were instructed to press the forward slash (/) key on the keyboard with their index finger as soon as the rectangle fills in with green (go cue) and told to not respond if the rectangle filled in with blue (no-go cue). The probability of a go or no-go target being displayed depended on the orientation (horizontal or vertical) of the cue. For example, vertically presented cues preceded a go target on 80% of the trials, and 20% on the no-go target trials. Contrastingly, horizontally presented cues preceded the no-go target 80% of the time, and 20% of the go target trials. Participants' anticipation of the exact onset of target was limited because of the randomness and variability provided by the different SOAs (either 100 ms, 200 ms, 300 ms, 400 ms, or 500 ms) between cues and targets.

Two hundred and fifty vertical cues and 250 horizontal cues were presented before an equal number of go and no-go target stimuli (250). Thus, the test consisted of 500 trials presented in four possible cue-target combinations. Each cue-target combination is presented at each of the five SOAs, and an equal number of SOAs separates each cue-target combination in random order. For each trial, a response or non-response was recorded by the computer, and if a response did occur, the reaction time (RT) measured in milliseconds was recorded. Feedback was displayed by presenting the words correct or incorrect along with the RT in milliseconds, to encourage rapid and accurate responses. The test required approximately 25 minutes to complete. This task yields a reaction time score and an accuracy score for each cue (i.e., a total of four scores). Poor behavioral control, as indicated by lower accuracy on the no-go cue in particular and quicker reaction times on both cues, have been demonstrated to be a valid measure of impulsivity in clinical populations, such as substance users and individuals

diagnosed with Attention Deficit Hyperactive Disorder (ADHD). Findings indicate substance users (e.g., Fillmore & Rush, 2006; Marczinski & Fillmore, 2003) and individuals diagnosed with ADHD (e.g., Yong-Liang, Robaey, Karayanidis, Bourassa, Pelletier, & Geoffroy, 2000; Weafer, Fillmore, & Millich, 2009) tend to display greater impulsivity on this task, as compared to controls. As such, in the present study, variables of interest included accuracy displayed on the no-go cue and cue reaction times, and these scores were used as mediators in path analyses.

**Craving.** Subjective craving was assessed by the Alcohol Urge Questionnaire (AUQ; Bohn, Krahn, & Staehler, 1995). The AUQ contains 8 items that assess craving for alcohol in the current context "right now." Each item is ranked on a 7-point Likert scale ranging from *strongly disagree* to *strongly agree.* Item responses are summed for a total score that range from 8-56, with higher scores indicating a stronger urge to drink alcohol. In addition to assessing alcohol-only cravings, this measure was modified to assess cravings for CAB. At baseline, internal consistency was .88 for alcohol-only craving and .82 for CAB craving. At the second timepoint, internal consistency was .84 for alcohol-only craving and .83 for CAB craving.

# CHAPTER III

## RESULTS

Descriptive statistics, correlations, and assumption analyses were conducted using IBM SPSS Statistics version 21, and ANCOVA and mediation analyses were tested using Mplus version 6.1 (Muthén & Muthén, 2008). Before any analyses were conducted, data were cleaned and two missing data points were labeled as missing on the caffeinated alcohol DDQ. Because responses from the caffeinated alcohol DDQ were only used for descriptive drinking data of the sample, these two participants were included in all analyses with the exception of baseline descriptives on typical caffeinated alcohol use. Assumptions of ANCOVA (i.e., independence of covariate/treatment and homogeneity of regression slopes) and residuals (i.e., homoscedasticity, independence, normality, multivariate outliers, multicollinearity) were checked, and histograms, boxplots, and Q-Q plots were used to assess normality, skewness, and kurtosis. Extreme outliers outside the 3 interquartile ranges were Winsorized (Barnet & Lewis, 1994) to match the next highest data point. The assumption for homogeneity of regression slopes was violated, as there was a significant interaction between baseline alcohol craving and group condition, $F(1,131) = 12.76$, $p < .001$. This assumption also was violated when examining baseline CAB craving and group condition, $F(1,131) = 9.03$, $p = .003$. As such, because random assignment was used and groups did not differ on baseline alcohol craving, $t(133) = -1.11$, $p = .269$, or baseline CAB craving, $t(133) = -.96$, $p = .337$, baseline alcohol and CAB craving were not included as covariates in subsequent analyses.

Prior to performing analyses, individual-level factors measured at baseline were examined to ensure that no differences between groups were present on typical alcohol

use, CAB use, trait impulsivity, and alcohol and CAB cravings. Groups did not differ in terms of typical alcohol use, $t(133) = -1.29$, $p = .201$, CAB use, $t(131) = -.95$, $p = .346$, trait impulsivity, $t(133) = -.22$, $p = .829$, baseline alcohol craving, $t(133) = -1.11$, $p = .269$, or baseline CAB craving, $t(133) = -.96$, $p = .337$. Group means and standard deviations can be found in Table 2, and correlations between variables can be found in Table 3.

Table 2

*Means and Standard Deviations of Measures per Group Condition*

| | **Control M (SD)** | **Experimental M (SD)** |
|---|---|---|
| Alcohol Quantity per Week | 8.84(7.12) | 10.76(10.12) |
| Alcohol Frequency per Week | 2.47(1.59) | 2.72(1.53) |
| Alcohol Binge Frequency per Week | .99(1.07) | 1.05(1.18) |
| CAB Quantity per Week | 5.38(5.25) | 6.32(6.20) |
| CAB Frequency per Week | 1.86(2.00) | 2.00(1.08) |
| CAB Binge Frequency per Week | .61(1.05) | .65(1.07) |
| Trait Impulsivity | 61.09(11.20) | 61.49(10.56) |
| Alcohol Craving *T1* | 15.00(6.64) | 16.46(8.61) |
| CAB Craving *T1* | 16.26(6.52) | 17.57(9.17) |
| Alcohol Craving *T2* | 16.66(7.03) | 20.22(10.52) |
| CAB Craving *T2* | 16.66(6.81) | 19.69(10.86) |
| Go Cue RT | 298.46(27.14) | 307.94(27.01) |
| No-go Cue RT | 313.60(26.47) | 324.25(26.41) |
| Go Cue Accuracy | .93(.07) | .94(.07) |
| No-go Cue Accuracy | .97(.05) | .97(.04) |

*Note.* CAB = Caffeinated Alcohol Beverage. *T1* = baseline (pre-exposure) assessment, *T2* = post-exposure assessment. RT = reaction time.

Table 3

*Intercorrelations among Study Variables*

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Condition | --- | | | | | | | | | | | |
| 2. Alcohol Use | .11 | --- | | | | | | | | | | |
| 3. CAB Use | .08 | .60*** | --- | | | | | | | | | |
| 4. Trait Impulsivity | .02 | .26** | .18* | --- | | | | | | | | |
| 5. Alcohol Craving *T1* | .10 | .27** | .13 | .27** | --- | | | | | | | |
| 6. CAB Craving *T1* | .08 | .30*** | .26* | .31*** | .81*** | --- | | | | | | |
| 7. Alcohol Craving *T2* | .20* | .29** | .19** | .31*** | .73*** | .71*** | --- | | | | | |
| 8. CAB Craving *T2* | .17 | .26** | .21* | .32*** | .59*** | .89*** | .72*** | --- | | | | |
| 9. Go Cue RT | .17* | .18* | .14 | .01 | .16 | .14 | .08 | .16 | --- | | | |
| 10. No-go Cue RT | .19* | .17 | .11 | -.05 | .14 | .10 | .09 | .14 | .84*** | --- | | |
| 11. Go Cue Accuracy | .06 | -.00 | -.03 | -.00 | .02 | .09 | .03 | .11 | .34*** | .19* | --- | |
| 12. No-go Accuracy | .06 | -.07 | -.02 | -.05 | -.03 | -.01 | -.04 | .04 | .07 | .20* | .57*** | --- |

*Note.* CAB = Caffeinated Alcohol Beverage, Condition: 0 = *Control*, 1 = *Experimental*, *T1* = baseline (pre-exposure) assessment, *T2* = post-exposure assessment., RT = reaction time. Typical quantity per week was reported for alcohol and CAB use.

*$p < .05$.; **$p < .01$.; ***$p < .001$.

## Analyses

**Drinking Characteristics.** Of the entire sample, participants reported consuming an average of 9.76 (*SD* = 8.71) alcohol-only drinks and 5.84 (*SD* = 5.73) CABs in a typical week. Regarding typical weekly frequency, participants reported consuming an average of 2.59 (*SD* = 1.56) alcohol-only occasions and 1.93 (*SD* = 1.18) CABs occasions per week. For weekly binge frequency, participants reported 1.01 (*SD* = 1.12) alcohol-only binge drinking occasions and .62 (*SD* = 1.06) CAB binge drinking occasions in a typical week. Paired samples *t*-tests were used to examine differences between typical alcohol-only and CAB drinking patterns. Results revealed that of the entire sample, participants consumed more alcohol-only drinks as compared to CABs, and this was found for typical quantity, $t(132) = 6.51$, $p < .001$, typical weekly frequency, $t(132) = 6.34$, $p < .001$, and typical weekly binge frequency, $t(132) = 4.44$, $p < .001$.

**Aim 1.** To test the influence of alcohol-related cues in the experimental condition, as opposed to the neutral condition, on subjective craving for alcohol and CAB.

***Hypothesis 1*.** It was hypothesized that participants exposed to alcohol-related cues in the experimental condition would report greater subjective alcohol and CAB craving, as compared to participants in the control condition. Two separate ANCOVAs were conducted to test mean differences in alcohol and CAB craving responses between conditions, while controlling for typical alcohol use quantity. Baseline alcohol and CAB craving were not included in the model, as the assumption of homogeneity of regression slopes was violated. However, conditions did not differ in baseline alcohol or CAB craving. The independent variable was environmental condition (0 = *neutral context*, 1 = *simulated bar context*). The dependent variables were subjective ratings of alcohol and CAB craving assessed after context exposure (i.e., at time 2), and typical alcohol use quantity was added as a control. Regarding alcohol-only craving, results revealed a significant main effect of condition, $F(1, 132) = 4.11$, $p = .045$, $\eta^2 = .030$, indicating that greater alcohol cravings were observed in the experimental condition above the influence of typical alcohol use (see Figure 3). Regarding CAB craving, results revealed that while controlling for typical alcohol use, subjective craving did not significantly differ between group conditions, $F(1, 132) = 2.82$, $p = .095$, $\eta^2 = .021$ (see Figure 4).

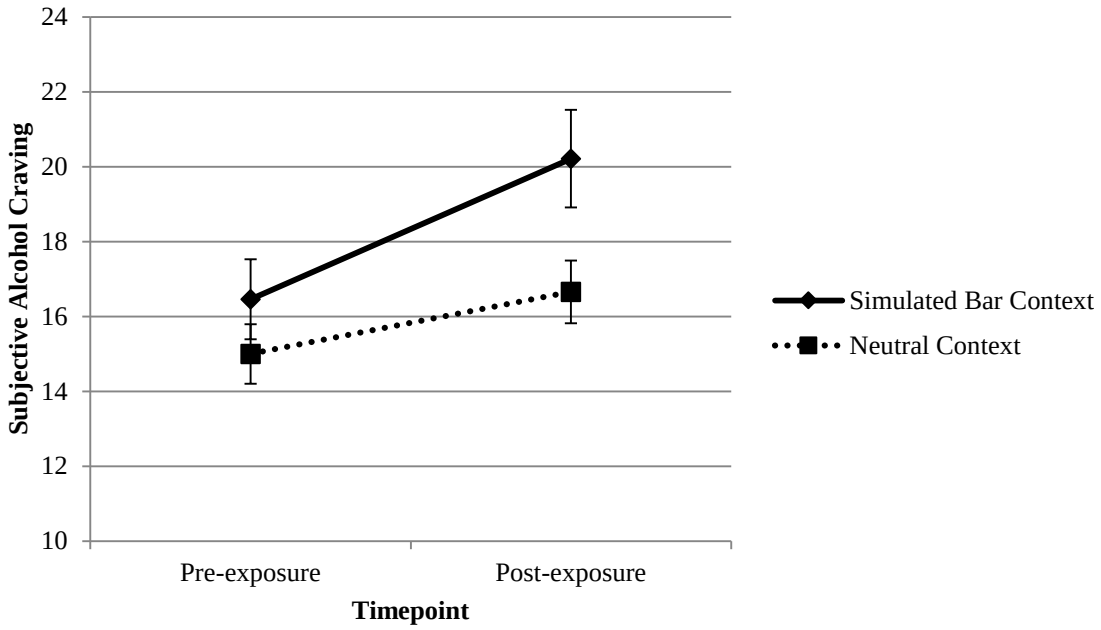


*Figure 3.* Mean differences in subjective alcohol craving at baseline and post-context exposure. Vertical bars indicate the standard error.

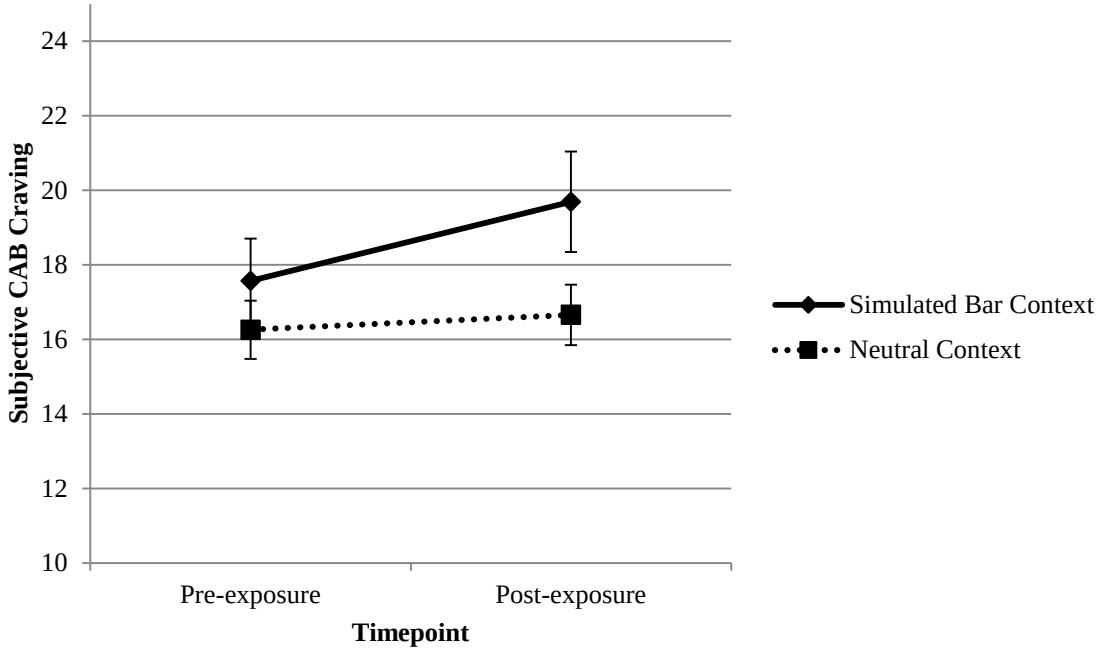


*Figure 4.* Mean differences in subjective CAB craving at baseline and post-context exposure. CAB = Caffeinated Alcohol Beverage. Vertical bars indicate the standard error.

**Aim 2.** To examine impulsivity as a mediator explaining the association between environmental context and subjective craving for alcohol and CAB (see Figure 2).

***Hypothesis 2.*** It was hypothesized that exposure to alcohol-related cues in the experimental condition would predict greater state impulsivity. In turn, this would predict greater cravings for alcohol and CAB. Path analyses were conducted to examine state impulsivity as a mediator of these associations, while controlling for trait impulsivity and typical alcohol use. Statistical significance was tested with 95% bias-corrected (BC) confidence intervals generated from 1,000 bootstrap samples. The parameter estimate is considered statistically significant if zero is not contained in the 95% BC confidence intervals (Preacher & Hayes, 2004).

Findings revealed that the indirect path from environmental context to alcohol craving (at time 2), through its influence on no-go cue accuracy was nonsignificant, $B$ = -0.01 with 95% BC CI [-0.03, 0.21]. The indirect path from environmental context to alcohol craving (at time 2), through its influence on go cue accuracy was nonsignificant, $B$ = 0.01 with 95% BC CI [-0.02, 0.04]. Regarding reaction times, the indirect path from environmental context to alcohol craving (at time 2), through its influence on no-go cue reaction time also was nonsignificant, $B$ = 0.00 with 95% BC CI [-0.07, 0.08]. Additionally, the indirect path from environmental context to alcohol craving (at time 2), through its influence on go cue reaction time was nonsignificant, $B$ = 0.02 with 95% BC CI [-0.05, 0.08].

For CAB cravings, findings revealed that the indirect path from environmental context to CAB craving (at time 2), through its influence on no-go cue accuracy was nonsignificant, $B$ = 0.00 with 95% BC CI [-0.01, 0.02]. The indirect path from

environmental context to CAB craving (at time 2), through its influence on go cue accuracy was nonsignificant, *B* = 0.01 with 95% BC CI [-0.02, 0.03]. Regarding reaction times, the indirect path from environmental context to CAB craving (at time 2), through its influence on no-go cue reaction time also was nonsignificant, *B* = 0.03 with 95% BC CI [-0.02, 0.07]. Last, the indirect path from environmental context to CAB craving (at time 2), through its influence on go cue reaction time was nonsignificant, *B* = 0.03 with 95% BC CI [-0.02, 0.07] (see Table 4).

Table 4

*Standardized Regression Coefficients for the Mediating Effect of State Impulsivity on Environmental Context and Craving*

| *Indirect effects* | *B* | *SE* | *p* | 95% CI |
|---|---|---|---|---|
| Condition → Go Cue RT → Alcohol Craving *T2* | 0.017 | 0.03 | 0.625 | -0.05, 0.08 |
| Condition → No-go Cue RT → Alcohol Craving *T2* | 0.003 | 0.04 | 0.927 | -0.07, 0.08 |
| Condition → Go Cue Accuracy → Alcohol Craving *T2* | 0.006 | 0.02 | 0.675 | -0.02, 0.04 |
| Condition → No-go Cue Accuracy → Alcohol Craving *T2* | -0.004 | 0.01 | 0.735 | -0.03, 0.02 |
| Condition → Go Cue RT → CAB Craving *T2* | 0.027 | 0.02 | 0.234 | -0.02, 0.07 |
| Condition → No-go Cue RT → CAB Craving *T2* | 0.027 | 0.02 | 0.248 | -0.02, 0.07 |
| Condition → Go Cue Accuracy → CAB Craving *T2* | 0.007 | 0.01 | 0.592 | -0.02, 0.03 |
| Condition → No-go Cue Accuracy → CAB Craving *T2* | 0.002 | 0.01 | 0.750 | -0.01, 0.02 |

*Note.* Condition: 0 = *Control*, 1 = *Experimental*, RT = reaction time, CAB = Caffeinated Alcohol Beverage, *T2* = post-exposure assessment. Typical alcohol use and trait impulsivity were added as controls. All paths were ns.

**Exploratory analyses.** Analyses were conducted to explore whether a moderation effect would be present among study variables. It is plausible that the alcohol-related context would elicit subjective craving for alcohol and CAB, but only for those who are high on trait impulsivity. As such, trait impulsivity was centered for moderation analyses, and typical alcohol use and baseline craving were added as controls. As seen in Table 4, trait impulsivity did not moderate the relationship between environmental condition and alcohol craving.

Table 5

*Standardized Regression Coefficients for Experimental Condition, Trait Impulsivity, and their Interaction on Craving*

| Regression and Predictors | *B* | *SE* | *p* | partial $r^2$ |
|---|---|---|---|---|
| Alcohol Craving *T2* | | | | |
| Alcohol Quantity | .07 | .06 | .258 | .10 |
| Alcohol Craving *T1* | .79 | .07 | <.001 | .69 |
| Condition | 2.22 | 1.05 | .036 | .18 |
| Trait Impulsivity | .10 | .07 | .158 | .12 |
| Condition X Trait Impulsivity | -.01 | .10 | .890 | -.01 |
| CAB Craving *T2* | | | | |
| Alcohol Quantity | .02 | .07 | .72 | .03 |
| CAB Craving *T1* | .77 | .08 | <.001 | .66 |
| Condition | 1.95 | 1.09 | .077 | .16 |
| Trait Impulsivity | .08 | .07 | .252 | .10 |
| Condition X Trait Impulsivity | .02 | .10 | .826 | .02 |

*Note.* CAB = Caffeinated Alcohol Beverage. *T1* = baseline (pre-exposure) assessment, *T2* = post-exposure assessment. Condition: 0 = *Control*, 1 = *Experimental.*

# CHAPTER IV

# DISCUSSION

The current investigation was the first to experimentally test the effect of an alcohol-relevant context on subjective alcohol and CAB craving through its effect on impulsivity among a sample of CAB college drinkers. It was hypothesized that exposure to alcohol-related cues in the simulated bar environment would elicit greater responses of subjective craving (i.e., alcohol and CAB). It was also predicted that state impulsivity would mediate the relationship between environmental context and subjective craving. That is, it was hypothesized that the alcohol-related context would influence one's level of impulsivity. In turn, impulsivity was expected to predict alcohol and CAB craving.

## Aim 1: Alcohol-related Context and Subjective Craving

Our first aim was to test the influence of environmental context (i.e., simulated bar versus neutral context) on subjective ratings of alcohol and CAB craving while controlling for baseline craving and typical alcohol use. Previous literature has supported that alcohol primes can elicit subjective alcohol craving. However, most of these studies have used alcohol primes such as an alcohol beverage (e.g., Heinz et al., 2013; Marczinski et al., 2013) or alcohol-related images (e.g., McCusker & Brown, 1990; Schulze & Jones, 2000) rather than an alcohol-relevant context, such as a simulated bar. The present study sought to extend our understanding of the role that the environmental context has specifically on one's desire to drink (i.e., craving). It was hypothesized that exposure to an alcohol-related context, as compared to a neutral context, would result in greater subjective craving for alcohol and CAB, above the influence of typical alcohol use and baseline craving. Overall, consistent with our prediction, greater subjective

craving for alcohol was reported by participants in the alcohol-related context, as compared to participants in the neutral context. This finding is consistent with prior work demonstrating the influence of environmental context on subjective alcohol craving (e.g., Bordnick et al., 2008; Jones et al., 2013). Regarding CAB specifically, albeit close ($p$ = .095), there was not a significant difference in subjective craving for CAB between group conditions while controlling for typical alcohol use. It is important to note that the effect size between the context and alcohol craving relationship was small ($\eta^2$ = .030), which is smaller than the medium effects (Cohen's $d$ range from 0.50-0.56) found in previous research (e.g., Carter & Tiffany, 1999; Jones et al., 2013; Kambouropoulos & Staiger, 2001). There are two potential reasons for this finding. First, the sample's age could have contributed to the small effect. The majority of our sample (about 81%) was under the legal drinking age of 21. Thus, many of our participants may not actually drink in bar environments, so the influence of this context on their craving may be less relevant than in past research using 21+ drinkers (e.g., Bordnick et al., 2008). Second, our study design did not specify a heavy drinking inclusion criteria, whereas most prior alcohol priming studies have (e.g., Christiansen et al., 2012; Fox et al., 2007; Joos et al., 2013). Because drinking levels have been shown to relate to the degree of alcohol cue priming (e.g., Papachristou et al., 2012a), it is possible that the relatively less severe drinking habits of our sample may have contributed to a weaker priming effect, and thus, to the extent that the bar environment sufficiently elicited craving. Despite our small effect size, our findings in general suggest that the alcohol-related context provided a salient cue that elicited subjective craving for alcohol among our sample of CAB college drinkers.

Our findings support theoretical assertions that alcohol cues can trigger positive incentive motivation for drug use (i.e., incentive-sensitization theory; Robinson & Berridge, 1993; 2001). In general, it is through the process of classical conditioning whereby alcohol-related stimuli are repeatedly paired with positive reinforcing effects, and subsequently increase the incentive value of alcohol. Theory suggests that these increases can result in greater appetitive (i.e., craving) responses to consume alcohol. Based on this theory in combination with previous research, we predicted that the role of drinking context would be of particular importance for CAB drinkers, as studies have shown CABs are more typically consumed in public venues (i.e., bars, nightclubs; Peacock et al., 2013), rather than in private residences. However, we found that exposure to the simulated bar condition significantly influenced subjective craving for alcohol, but not for CABs specifically. Although it was initially hypothesized that alcohol and CAB cravings would emerge as two separate constructs, it is important to note that it's plausible that they are not given their high correlation with each other across pre and post context exposure ($r$ = .71 and above). Thus, we cannot confirm our initial hypothesis that CAB drinkers experience more craving for CAB specifically when in alcohol-related contexts. This pattern of findings could be because our sample reported greater alcohol-only consumption patterns (typically consuming 9.76 drinks, 2.59 days, and 1.01 binge drinking days, per week), as compared to CAB (typically consumed 5.84 drinks, 1.93 days, and 0.62 binge drinking days, per week). Thus, it may be that alcohol cues are more salient for their craving for alcohol specifically because they reported greater alcohol-only versus CAB use. Future work may want to include CAB consumers who

drink similar amounts of alcohol-only beverages and CABs, as this could influence craving outcomes.

The relationship between environmental context and alcohol craving has important implications for alcohol-related harms among CAB consumers. In particular, previous research supports that CAB consumption is associated with a higher likelihood of experiencing alcohol-related harms (e.g., Lau-Barraco et al., 2014; Snipes & Benotsch, 2014; Thombs et al., 2010). However, there is little research that has sought to explain *why* CAB use is related to problems. Given that the present study found that an alcohol-relevant context elicited greater levels of alcohol craving, one factor that may contribute to alcohol harm in CAB consumer is craving, especially when in bar environments. CAB consumers may be more vulnerable to experiencing subjective craving when presented with alcohol stimuli, which in turn may contribute to their propensity to drink more heavily, and consequently experience more alcohol-related harms. Although we did not measure actual alcohol consumption, laboratory studies have well-established a link between self-reported craving and subsequent ad libitum drinking (e.g., Christiansen et al., 2012; Schulze & Jones, 2000; Walitzer & Sher, 1990) with those reporting higher craving also consuming more alcohol. As such, this greater level of drinking may result in greater alcohol-related problems experienced. This is supported by research showing that the level of drinking at bars is related to experiences with alcohol-related problems (e.g., Harford, Wechsler, & Muthen, 2003; Marzell, Bavarian, Paschall, Mair, & Saltz, 2015). Given that CAB consumers may be more likely to drink in bars (e.g., Peacock et al., 2013), intervention strategies that target drinking in bar environments, including education about subjective craving, may be beneficial in reducing alcohol harms.

Overall, findings from our first aim support that environmental cues can trigger one's craving or motivation to consume alcohol, and this effect is beyond the influence of the amount of alcohol one typical consumes. This increase in reactivity to alcohol-related stimuli is robustly observed in alcohol-dependent populations when compared to healthy controls (see Drummond, 2000 for review). Given that a similar response was observed among our sample, it may be that this particular population of drinkers is vulnerable for alcohol harm.

**Aim 2: Impulsivity as a Mediator between Context and Craving**

The second aim of the present study sought to test the effect of environmental context on subjective alcohol and CAB craving through its influence on state impulsivity. Previous research has demonstrated that drinkers display impaired inhibitory control (i.e., greater impulsivity) when primed with alcohol-related stimuli (e.g., Gauggel et al., 2010; Noel et al., 2007; Weafer & Fillmore, 2012). Additionally, associations between state impulsivity and craving have been reported, such that those displaying greater impulsivity on objective tasks also report more craving subjectively (Papachristou et al., 2012a; Joos et al., 2013). However, this prior work has not utilized a real-world drinking context such as a simulated bar, with the exception of one study (Jones et al., 2013), and has yet to be explored among CAB drinkers. As such, this investigation sought to further our understanding of the association between environmental context and craving by testing state impulsivity as an underlying mechanism. We hypothesized that similar to alcohol-only studies, CAB users would display more impulsive behavior during exposure to an alcohol-related context. In turn, this greater impulsive response would positively

predict one's craving for alcohol and CAB. We predicted this effect would be above the influence of one's typical alcohol consumed, baseline craving, and trait impulsivity.

**State impulsivity and Craving.** Regarding state impulsivity, the current study did not find that our measurement of impulsivity significantly mediated the association between environmental context and craving for alcohol or CAB. Specifically, we first examined whether environmental context predicted lower accuracy on the no-go cue (i.e., failure to inhibit responses) and whether this in turn predicted craving for alcohol. We also tested this indirect path with other scores reported from the cued go/no-go task (i.e., accuracy on the go cue, reaction times for go and no cues) as mediating variables. Contrary to our predictions, all of these indirect paths were nonsignificant. Further, when CAB craving was the outcome, we found similar results in that no significant indirect paths were identified. As such, our findings do not support our original hypothesis that state impulsivity would mediate the association between environmental context and craving. Because beta coefficients from these indirect paths are near zero ($B < 0.03$), it is unlikely that our lack of significant findings are due to insufficient power.

Upon examining the bivariate correlations among our study variables (see Table 3), findings revealed that context condition was not related with accuracy on either cue on the cued go/no-go task. These findings are consistent with Jones et al. (2013) which also failed to find differences in response inhibition between their simulated bar and neutral conditions in their sample of alcohol-only drinkers. However, the current study findings and findings from Jones et al. (2013) are inconsistent with the larger literature that has found support for cue-elicited impulsivity using other types of alcohol stimuli (e.g., olfactory cues, alcohol images). One potential explanation for this finding is that a

baseline measure of state impulsivity was not included in the current investigation. Therefore, potential changes in state impulsivity may have been present between group conditions, but were not assessed. Another potential explanation for this pattern of findings may be clarified through theoretical models of impulsivity, particularly the activation and inhibition processes of behavioral control. Specifically, we predicted that CAB drinkers would show increased craving in response to the simulated bar because they displayed deficient response inhibition. That is, individuals would experience more craving when presented with the alcohol-related context because they have difficulty inhibiting such responses. But, it may be that CAB consumers display a stronger approach (activation) system, as compared to a deficient inhibitory system. In particular, this system has been associated with a greater predisposition for detecting and approaching rewarding stimuli (e.g., Dawe et al., 2004), which may be more relevant in incentive-sensitization theory than inhibition. Furthermore, according to theory, a stronger approach system may predispose individuals to greater craving because they experience greater salience of alcohol cues (see Dawe et al., 2004 for review). Thus, future research may wish to include behavioral tasks that tap into the behavioral approach system (e.g., sensitivity to reward tasks). Such investigations may offer an alternative explanation for why greater craving was observed in our simulated bar condition.

An even more surprising finding was that participants in the alcohol-related context, as compared to participants in the neutral context, displayed significantly *slower* reaction times on both the go and no-go cues. As such, participants took a longer time when in the simulated bar, as compared to participants in the neutral context, to select correct responses. This finding does not support our original hypothesis, as we predicted

individuals in the simulated bar would experience greater impulsivity and thus report quick, incorrect responses. However, although this is contrary to our hypothesis, it is consistent with the broader addiction literature that supports the effects of alcohol-related cues on cognitive processing across many paradigms (e.g., Cox, Yeates, & Regan, 1999). For example, Tiffany (1990) suggested that subjective craving utilizes cognitive resources. Consequently, it may be that the slowing in reaction times observed in our study is a consequence of subjective craving experienced in the simulated bar.

**Trait Impulsivity and Craving.** Although no predictions were made about the relationship between trait impulsivity and craving, bivariate correlations among variables in our study were the first to demonstrate significant associations between trait impulsivity and craving for alcohol *and* CAB. That is, higher levels of trait impulsivity were associated with greater subjective craving responses for alcohol and for CAB at baseline and post context exposure. Further, these relationships were observed in both context conditions.

We also found that a greater level of trait impulsivity was associated with greater self-reports of typical alcohol and CAB consumption, which is consistent with previous research (e.g., Amlung et al., 2013; Heinz et al., 2013). As such, trait impulsivity appears to be an influential variable in determining one's level of consumption as well as their motivation to drink. To date, the CAB literature is uncertain as to whether CAB use itself influences risky behaviors or if these CAB-related risks are a consequence of particular personality characteristics (e.g., impulsivity) of the consumer. Given this gap in our understanding of CAB, future research should attempt to clarify trait impulsivity's role in CAB use and alcohol-related problems.

**General Discussion**

Overall, some of the current study hypotheses were supported. Specifically, we found that an environmental context can elicit responses for alcohol among consumers of CAB. However, we did not find that state impulsivity explained this association. As such, these findings have important implications for prevention efforts in college CAB drinkers. CAB use, compared to alcohol-only use, has been linked with a host of alcohol problems including physical injury (O'Brien et al., 2008) and driving with someone intoxicated (Brache & Stockwell, 2011); and CAB are more typically consumed in bars/nightclubs (Peacock et al., 2013), rather than in residences. In our study, we demonstrated that a simulated bar context can trigger subjective craving for alcohol in consumers of CAB. Thus, it may be that these individuals who drink in bar environments are at greater risk for heavy drinking and alcohol problems because they experience more craving, and thus more motivation to consume alcohol. Given the popularity of CABs in public venues, intervention efforts that specifically target drinking at bars/nightclubs may be beneficial in reducing alcohol-related harms in this population. Despite that we did not find that *state* impulsivity explained the association between environmental context and craving, we did find that *trait* impulsivity was associated with greater alcohol and CAB use and greater levels of subjective craving in general. Thus, trait impulsivity appears to be an influential factor in drinking behavior and one's response to alcohol-related cues, regardless of context. Although our measure of state impulsivity was not significantly related to these constructs, trait impulsivity may be a viable candidate to explore in relation to CAB use in future research. Intervening efforts may wish to target

CAB consumers that exhibit high levels of trait impulsivity. Such efforts may be most beneficial in reducing risky alcohol behaviors among CAB drinkers.

**Future Directions**

There are several directions that can be explored to advance our knowledge on the relationships between impulsivity and cue-elicited craving, specifically among CAB consumers. First, craving in our study served as a proxy for actual alcohol consumption. Future research may want to incorporate an ad libitum alcohol consumption task to assess how the environment, impulsivity, and craving influence the immediate consumption of alcohol or of CAB. Further, it may be that response inhibition is more strongly related to actual drinking behavior, rather than motivation to consume alcohol (see Dawe & Loxton, 2004 for review). Second, we did not include CAB-specific cues (e.g., Red Bull signs) in our simulated bar environment, which may explain why no effect on CAB craving was observed. Future research may want to implement such cues to fully understand the relationship between alcohol and CAB stimuli and CAB craving responses. Third, our study used the cued go/no-go task to measure state impulsivity and found no significant relationships with environmental context or with subjective craving. Thus, future work should assess other measures of state impulsivity that tap into different dimensions of impulsive behavior. These may include a delay discounting task or a measure of reward sensitivity. Additionally, because CAB use has been implicated in risk-taking behavior during drinking occasions, it may be beneficial to utilize a behavioral task that measures risk-taking behavior (e.g., the Balloon Analogue Risk Task). Finally, it's important to note that not all drinkers experience craving in the presence of alcohol stimuli (e.g., Litt et al., 2000). As such, future research should

explore other moderators/mediators that may help explain the association between alcohol cues and craving. Contrary to our prediction, we did not find impulsivity to be an underlying mechanism of this relationship. However, other personality characteristics (e.g., self-regulation, sensation seeking) or alcohol-related cognitions (e.g., alcohol and CAB-specific expectancies) may be offer meaningful explanations for why cue-elicited craving occurs, particularly among CAB drinkers.

**Limitations**

There are limitations to the current study. First, our sample of consumers of CAB consisted primarily of moderate college drinkers who were female (66.7%), under 21 (approximately 81%), and Caucasian. Thus, our study findings may not be generalizable to other populations (e.g., noncollege students, other ethnicities, or other age groups). Second, participants were tested in groups of three, and confederates were used when study sessions were not full. Although no participant indicated that they were aware of confederates during the study, we are uncertain as to whether or not this had an effect on the experiment. Third, baseline performance on the impulsivity task was not measured. As such, it is possible that changes in state impulsivity occurred, but before and after context exposure were not assessed. Lastly, the present study focused on specific definitions and measurements of impulsivity that may be related to alcohol-related cues and subjective reports of craving. Future research may want to assess other behavioral measures of impulsivity (e.g., sensitivity to reward measures) as these may be more strongly related to our study variables.

# CHAPTER V

# CONCLUSIONS

The present study represented the first to examine the associations between environment context, state and trait impulsivity, and subjective craving in a sample of CAB drinkers. Specifically, this study examined the effect of alcohol-related cues in a simulated bar context on subjective craving responses for alcohol and CAB, through its influence on state impulsivity. Overall, study findings revealed that greater subjective responses for alcohol, but not for CAB, were observed in an alcohol-related context as compared to a neutral context. State impulsivity was not an underlying mechanism of this association, whereas trait impulsivity was significantly related to more alcohol and CAB craving at baseline and post-exposure to context condition. Future research may benefit from determining the role trait impulsivity has in CAB consumption, as its relationship may help explain why CAB drinkers are shown to engage in more risky alcohol behaviors.

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# APPENDIX A

## Demographic Questionnaire

**1) How old are you?**

_____

**2) What is your student class (circle one)?**
a. Freshman
b. Sophomore
c. Junior
d. Senior
e. Graduate student
f. Other (please specify): _____

**3) What is your gender?**
a. Female
b. Male

**4) What is your race?**
a. African American/Black
b. Caucasian/White
c. Asian
d. Hispanic
e. Native Hawaiian or Other Pacific Islander
f. Native American or Alaskan Native
g. Other (please specify): _____

**5) Are you currently a member of a fraternity or sorority on campus?**
a. Yes
b. No

**6) What is your height?**
_____ feet, _____ inches

**7) What is your weight?**
_____ pounds

**8) What is your relationship status?**
a. Single/never married
b. Living with partner
c. Married
d. Separated/Divorced
e. Widowed

**9) Are you employed now?**
a. Yes, part-time only
b. Yes, full and part-time
c. Yes, full time only
d. No

**10) What is your current overall GPA?**

**_____**

# APPENDIX B

## Alcohol Use (NON-CAFFEINATED ALCOHOL) Questionnaire

The following questions have to do with non-caffeinated alcohol use. For these questions, please choose the answer that best describes your drinking in the **past 3 months**.

1. Please think about your typical drinking over the **PAST 3 MONTHS NOT INCLUDING CAFFEINATED ALCOHOL**. This includes alcoholic beverage where you did you not mix caffeine with alcohol. Examples are:

> Note: 1 Drink = 1 Beer (12 ounces)
> 1 Wine Cooler (12 ounces)
> 1 Glass of Wine (5 ounces)
> 1 Shot of Liquor (1 to 1.5 ounces)
> 1 Non-caffeinated Mixed Drink (1 to 1.5 ounces of liquor)
> 1 Malt Liquor (12 ounces) – e.g., Mike's Hard Lemonade, Skyy Blue, Zima, Smirnoff Ice, etc.

On a typical day, how many drinks would you have, and over how many hours would you have them? That is, how many drinks would you typically have on each day in the past three months? How long (in hours) would a typical drinking occasion last on that day?

Over the **PAST 3 MONTHS**, on a….

| | TYPICAL MONDAY | TYPICAL TUESDAY | TYPICAL WEDNESDAY | TYPICAL THURSDAY | TYPICAL FRIDAY | TYPICAL SATURDAY | TYPICAL SUNDAY |
|---|---|---|---|---|---|---|---|
| NUMBER OF DRINKS | | | | | | | |
| NUMBER OF HOURS | | | | | | | |

1. Think of the one occasion during the past 30 days when you drank the most:
   8a1. How many standard drinks did you consumed? ____ drinks
   8a2. Over how many hours did you consume this drinks (i.e., how long did it take for you to consume those drinks? ____ hours

# APPENDIX C

## Caffeinated Alcohol Questionnaire

The following questions have to do with caffeinated alcohol use. For these questions, please choose the answer that best describes your drinking in the **past 3 months**.

Note: 1 Drink = 1 Energy drink with alcohol (e.g., Red Bull and Vodka; Jager Bomb)
= 1 Pre-packaged caffeinated alcohol (e.g., Caffeinated beer: Sparks, Rockstar; caffeinated liquor – Joose or P.I.N.K.)
= 1 Coffee with alcohol (e.g., Irish Coffee)

Please think about your typical drinking of caffeinated alcohol over the **PAST 3 MONTHS**. On a typical day, how many drinks would you have, and over how many hours would you have them? That is, how many drinks would you typically have on each day in the past three months? How long (in hours) would a typical drinking occasion last on that day? **In the third row, indicate if you consumed an energy drink specifically (e.g., Red Bull, Monster, Rockstar) on this day.**

Over the **PAST 3 MONTHS**, on a….

| | TYPICAL MONDAY | TYPICAL TUESDAY | TYPICAL WEDNESDAY | TYPICAL THURSDAY | TYPICAL FRIDAY | TYPICAL SATURDAY | TYPICAL SUNDAY |
|---|---|---|---|---|---|---|---|
| NUMBER OF DRINKS | | | | | | | |
| NUMBER OF HOURS | | | | | | | |
| Consumed energy drink? (Yes/No) | | | | | | | |

1. How many times (i.e., how many drinks) in the past 30 days did you drink alcohol that was mixed with an energy drink (e.g., Red Bull and vodka)? _____

2. How many days in the past 30 days did you drink alcohol that was mixed with an energy drink (e.g., Red Bull and vodka)? _____

# APPENDIX D

## Barratt Impulsiveness Scale version 11

**DIRECTIONS**: People differ in the ways they act and think in different situations. This is a test to measure some of the ways in which you act and think. Read each statement and put an X on the appropriate circle on the right side of this page. Do not spend too much time on any statement. Answer quickly and honestly.

| | Rarely | Never/ Occasionally | Often Almost/ Always | Always |
|---|---|---|---|---|
| 1 I plan tasks carefully. | | | | |
| 2 I do things without thinking. | | | | |
| 3 I make-up my mind quickly. | | | | |
| 4 I am happy-go-lucky. | | | | |
| 5 I don't "pay attention." | | | | |
| 6 I have "racing" thoughts. | | | | |
| 7 I plan trips well ahead of time. | | | | |
| 8 I am self controlled. | | | | |
| 9 I concentrate easily. | | | | |
| 10 I save regularly. | | | | |
| 11 I "squirm" at plays or lectures. | | | | |
| 12 I am a careful thinker. | | | | |
| 13 I plan for job security. | | | | |
| 14 I say things without thinking. | | | | |
| 15 I like to think about complex problems. | | | | |
| 16 I change jobs. | | | | |
| 17 I act "on impulse." | | | | |
| 18 I get easily bored when solving thought problems. | | | | |
| 19 I act on the spur of the moment. | | | | |
| 20 I am a steady thinker. | | | | |

| | | | | |
|---|---|---|---|---|
| 21 I change residences. | | | | |
| 22 I buy things on impulse. | | | | |
| 23 I can only think about one thing at a time. | | | | |
| 24 I change hobbies. | | | | |
| 25 I spend or charge more than I earn. | | | | |
| 26 I often have extraneous thoughts when thinking. | | | | |
| 27 I am more interested in the present than the future. | | | | |
| 28 I am restless at the theater or lectures. | | | | |
| 29 I like puzzles. | | | | |
| 30 I am future oriented. | | | | |

## APPENDIX E

### Alcohol Urge Questionnaire

INSTRUCTIONS: Listed below are questions that ask about your feelings about drinking. The words " drinking" and "have a drink" refer to having a drink containing alcohol (**WITHOUT CAFFEINE**), such as beer, wine, or liquor. Please indicate how much you agree or disagree with each of the following statements. The closer you place your mark to one end or the other indicates the strength of your disagreement or agreement. Please complete every item. We are interested in how you are thinking or feeling right now as you are filling out the questionnaire.

### RIGHT NOW

| | Strongly Disagree 1 | 2 | 3 | 4 | 5 | 6 | Strongly Agree 7 |
|---|---|---|---|---|---|---|---|
| 1. All I want to do now is have a drink. | | | | | | | |
| 2. I do not need to have a drink now. | | | | | | | |
| 3. It would be difficult to turn down a drink this minute. | | | | | | | |
| 4. Having a drink now would make things seem just perfect. | | | | | | | |
| 5. I was a drink so bad I can almost taste it. | | | | | | | |
| 6. Nothing would be better than having a drink right now. | | | | | | | |
| 7. If I had the chance to have a drink, I don't think I would drink it. | | | | | | | |
| 8. I crave a drink right now. | | | | | | | |

## APPENDIX F

## Modified Caffeinated Alcohol Urge Questionnaire

INSTRUCTIONS: Listed below are questions that ask about your feelings about drinking. The words " drinking" and "have a drink" refer to having a drink containing alcohol **WITH CAFFEINE**, such as a rum and Coke or Red Bull vodka. Please indicate how much you agree or disagree with each of the following statements. The closer you place your mark to one end or the other indicates the strength of your disagreement or agreement. Please complete every item. We are interested in how you are thinking or feeling right now as you are filling out the questionnaire.

**RIGHT NOW**

| | Strongly Disagree 1 | 2 | 3 | 4 | 5 | 6 | Strongly Agree 7 |
|---|---|---|---|---|---|---|---|
| 1. All I want to do now is have a drink. | | | | | | | |
| 2. I do not need to have a drink now. | | | | | | | |
| 3. It would be difficult to turn down a drink this minute. | | | | | | | |
| 4. Having a drink now would make things seem just perfect. | | | | | | | |
| 5. I was a drink so bad I can almost taste it. | | | | | | | |
| 6. Nothing would be better than having a drink right now. | | | | | | | |
| 7. If I had the chance to have a drink, I don't think I would drink it. | | | | | | | |
| 8. I crave a drink right now. | | | | | | | |

# APPENDIX G

## COLLEGE STUDENT COGNITIVE PERFORMANCE STUDY SCRIPT

***Introduction***

"Hi, my name is Amy, and I am your study coordinator today. I would like to thank you for volunteering to participate. To ensure that everyone has the same understanding about the experiment, I am going to read some information to you. The purpose of this study is to learn more about your behaviors and attitudes. Today's session will involve first completing several study questionnaires, then performing a computer task and finally ending with you completing several more study questionnaires. These various tasks and questionnaires are meant for us to get a better understanding of your thoughts, behaviors, and different lifestyle habits. One of the things we are particularly interested in is your attitudes throughout the study today, so it is possible that you will see similar questions being asked of you throughout the study. Also, there is a meeting in this room shortly, so once you are done with the first set of questions, we will go to another room so you can complete the computer task and the study. Once you are done with the study today, you will receive 1.0 SONA credit**.** The total time required of you today will be approximately 1 hour. If you have any questions throughout the study, please don't hesitate to ask – just raise your hand. If you need to do the restroom, please do so now, because you will not be able to leave the study once we start. Also, please make sure you silence your cell phones. Does that sound good to everyone?"

"Great. On the computer screen is the informed consent. Please read over this, as it goes over your rights as a participant in this study. Please read over the eligibility requirements to make sure that you are eligible to participate in this study. These include that you are between 18-25, have consumed caffeinated alcohol in the past month (so like Redbull and vodka, or rum and Coke), that you have not had a seizure, and that you have normal color vision. If you agree to participate, please select "Next". If you do not wish to continue participating, please let me know. Any questions?

Let me know when you have finished going over the consent form."

ID:
"To create an ID, please use…
Create ID number: This ID number will be comprised of their birth month, birth date, and the last four digits of their cell phone number (e.g., if someone was born on January 2nd with the last four digits of 1234, their ID number would be 01021234).
After you enter your ID, you will complete a set of questionnaires. Please let me know when you have reached the page indicating you have completed them."

***Baseline Questionnaires:***

1. ***Baseline Alcohol Craving***
2. ***Baseline CAB Craving***
3. ***Demographics***
4. ***DDQ***
5. ***DDQ – CAB use***
6. ***Barrett Impulsivity Scale***

***Take participant to room condition – either bar or neutral***

***Cued RT Test***

"This is a reaction time task that I would like you to perform. While you are performing the task, you sit in front of the computer screen. You place your index finger on the '?' key.

Presented on the screen will be rectangles that are green or blue in color. If the color GREEN appears on the screen, you are to press the '?' button as quickly as possible. If the color BLUE appears on the screen, then no response is required.

Now, before the green or blue color appears, you will see a plus sign in the middle of the screen. It serves as a fixation point so that you know where to focus your attention on the computer screen. After the plus sign disappears, a cue rectangle will appear on the screen. This is a black outline of a rectangle and lets you know that a color is about to appear. Do not respond to any cue. They are just there to get you ready to respond to the GREEN and BLUE colors. If the color GREEN appears, respond as quickly as possible by pressing the '?' key. If the color BLUE appears, then no response is required.

Any questions about that?

To help you to respond quickly, the computer will display how fast you are pressing the key when the target appears in milliseconds once you respond. The fewer the milliseconds, the faster the response, so lower numbers are better. If you accidentally respond to a blue target, the screen will say 'Incorrect'. Please be as fast and accurate as possible.

So just to recap, if the color GREEN appears, press the key as quickly as possible. If the color BLUE appears, no response is required.

The time to complete this test is about 25 minutes that includes 4 1-minute breaks. In the breaks, a beep will sound when there are 10 seconds left on the break, so that you may get ready to start again. Please pay attention to the task throughout the entire session and try not to dream or become distracted. When the test is over, please open the door so that I will know that you are done.

OK, press the spacebar to start and the question mark key from then on. Remember to respond as quickly as possible and do your best." *(Make sure they start the test and understand the directions and then leave the room and shut the door.)*

**After everyone has completed task: "**Okay, now you are going to complete a second set of questionnaires. You will use the same ID that you used earlier (Birth month/day/last 4 digits of cell phone). One you have finished reading over the debriefing statement, you are free to leave. Thanks for you participation! I will update your SONA credit this evening. Please let me know if you have any questions."

***Alcohol Craving Questionnaire***
***CAB Craving Questionnaire***
***Deception Assessment***
***Short Debriefing Form***

# APPENDIX H

## DECEPTION QUESTIONNAIRE

1. What do you believe the tasks you participated in today were about?

Computer Task: _____

Moving locations: _____

Questions on your feelings about alcohol: _____

Other: _____

# APPENDIX I

## SHORT DEBRIEFING HANDOUT

This study is concerned with caffeinated alcohol use, impulsivity, and alcohol craving among college students. In this study, you were asked to perform an experimental task—the cued go/no-go task.

Findings from this study will advance our understanding of college student alcohol use and related behaviors.

All the information we collected in today's study will be kept confidential. We are not interested in any one individual's responses; we want to look at the general patterns that emerge when the data are aggregated together.

We also ask that you do not discuss this study with other students. In order to collect the most accurate information, and to maintain research integrity, it is important that participants are not aware of what we are interested in examining.

If your participation in this study has caused you concerns, anxiety, or otherwise distressed you, you may want to contact the ODU Counseling Center at (757) 683-4401.

If you have questions about your participation in this study or would like to contact the researcher, please email Amy Stamates, B.S., at astamate@odu.edu.

Thank you again for your participation.

## APPENDIX J

## FULL DEBRIEFING HANDOUT

This study is concerned with the effect of alcohol primes and impulsivity on alcohol craving. Previous studies have found that alcohol-related primes can lead to greater impulsivity and influence subsequent behaviors. By viewing alcohol cues, your impulsivity and alcohol craving may increase.

How was this tested?
In this study, you were asked to perform a cued go/no-go task and to report your level of alcohol craving. All participants performed these same tasks, though one group was exposed to alcohol-related cues, whereas the other group was not presented with such cues.

Hypotheses and main questions:
We expect to find that exposure to alcohol-related cues will increase your impulsivity and thus increase your craving for alcohol. When we examine these items, we expect individuals who were brought into a bar environment to express greater impulsivity and more alcohol craving.

Why is this important to study?
Findings from this study will advance our understanding of the development of alcohol problems, specifically for caffeinated alcohol users. If we understand the triggers of risky behaviors, we can help those understand why they may engage in risky behaviors.

What if I want to know more?
If you are interested in learning more about different types of impulsivity and risks related to caffeinated alcohol use, you may want to consult:

(1) Linden, A. N., & Lau-Barraco, C. (2014). A qualitative review of psychosocial risk factors associated with caffeinated alcohol use. *Experimental and Clinical Psychopharmacology, 22,* 144-153. doi: 10.1037/a0036334
(2) Dick, D. M., Smith, G., Olausson, P., Mitchell, S. H., Leeman, R.F., O'Malley, S., … (2010). Understanding the construct of impulsivity and its relationship to alcohol use disorders. *Addiction Biology, 15,* 217-226. doi: 10.1111/j.1369-1600.2009.00190.x

All the information we collected in today's study will be confidential. We are not interested in any one individual's responses; we want to look at the general patterns that emerge when the data are aggregated together.

If your participation in this study has caused you concerns, anxiety, or otherwise distressed you, you may want to contact the ODU Counseling Center at (757) 683-4401.
If you have questions about your participation in this study or would like to contact the researcher, please email Amy Stamates, B.S. at astamate@odu.edu

Thank you again for your participation.

# VITA

Amy L. Stamates

Old Dominion University
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## Education and Training

**Ph.D.** **Old Dominion University,** *Norfolk, VA*
Applied Experimental Psychology, 2018 (Expected)
Advisor: Cathy Lau-Barraco, Ph.D.

**M.S.** **Old Dominion University,** *Norfolk, VA*
Applied Experimental Psychology, 2016 (Expected)
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**B.S.** **Northern Kentucky University,** *Highland Heights, KY*
Psychology, Honors, 2010
Advisor: Cecile A. Marczinski, Ph.D.

## Background

Amy L. Stamates (née Henges) is a third year graduate student at Old Dominion University. She is pursuing her Master's degree in Applied Experimental Psychology and, in Spring 2016, her Ph.D. in Applied Experimental Psychology. For the past two years, she has served as the project coordinator for Dr. Cathy Lau-Barraco's K01 career grant funded by the National Institute of Health. Her research interests include risky alcohol use patterns (e.g., Red Bull and vodka, diet mixers) and understanding the role of impulsivity in alcohol use behaviors.

## Selected Publications

**Stamates, A. L.,** Lau-Barraco, C., & Linden-Carmichael, A. N. (in press). Alcohol expectancies mediate the relationship between age of first intoxication and drinking outcomes in college binge drinkers. *Substance Use & Misuse.*

**Stamates, A. L.,** Maloney, S. F., & Marczinski, C. A. (in press). Effects of artificial sweeteners on breath alcohol concentrations in male and female social drinkers. *Drug and Alcohol Dependence.*

**Henges, A. L**. & Marczinski, C. A. (2012). Impulsivity and alcohol consumption in young social drinkers. *Addictive Behaviors*, *37*, 217-220. doi:10.1016/j.addbeh.2011.09.013