Individual Differences in Reinforcing Value of Alcohol After a Priming Dose Among High-Risk College Students

by

Andrea Rose Diulio

A dissertation submitted to the Graduate Faculty of
Auburn University
in partial fulfillment of the
requirements for the Degree of
Doctor of Philosophy

Auburn, Alabama
August 1, 2015

Keywords: alcohol, priming effect, behavioral economics, multiple choice procedure

Approved by

Chris Correia, Chair, Professor of Psychology
Tracy Witte, Assistant Professor of Psychology
Alejandro Lazarte, Associate Professor of Psychology
Jeffrey Katz, Alumni Professor of Psychology

Abstract

The priming effect refers to an increase in the desire for more of a substance after consuming an initial dose. Sensitivity to the priming effect among drinkers is considered a risk factor for hazardous drinking. Drinkers experiencing a priming effect display experience greater motivation to consume more alcohol, rather than becoming satiated, after initiating a drinking episode, which may lead to heavy drinking episodes and alcohol-related problems. Previous studies have identified a number of factors that may be related to the priming effect; however, none have used a standardized behavioral economics choice procedure, nor have drinking motives been used to account for variance in the priming effect. The present study found significant differences in responding on the choice procedure between the sessions in which participants consumed an alcohol preload compared to a placebo, suggesting the presence of a priming effect. However, analyses did not reveal that individuals reported greater craving for alcohol in the alcohol condition, nor were differences in drinking motives, affect or stimulating effects in alcohol observed. Regression analyses revealed that greater sedating effects of alcohol and reported craving after consuming the alcohol preload may be related to enhanced sensitivity to the priming effect. Implications for how priming research can influence clinical interventions among college students, as well as what improvements can be made in priming-related research are discussed.

Table of Contents

List of Tables

List of Figure

INTRODUCTION

Alcohol and College Students

Heavy drinking among college students is a major public health concern. The majority of college students aged 18 to 22 (61%) report consuming alcohol in the past month, and nearly half (40%) report at least one binge episode (5≥ drinks for males and 4≥ drinks for females; Wechsler, Dowdall, Davenport, & Rimm, 1995) and 14% engage in binge drinking five or more times over the same time frame (Substance Abuse and Mental Health Services Administration, 2012).

There is evidence to suggest that although drinking any amount can be associated with alcohol-related problems, college students who consume more than three drinks in one drinking occasion are five times more likely to experience problems than their peers who drink less (Gruenwald, Johnson, Poinicki, & LaScala, 2010). Additionally college students who binge drink are at a 10-time greater risk of experiencing alcohol-related problems than their peers who abstain or drink moderately; further students who binge three or more times during a 2 week period are more likely to report serious alcohol-related problems that can have long lasting consequences on the students' life (Wechsler, Davenport, Dowdall, Moeykens, & Castillo, 1994). For example, frequent binge drinking students are seven to ten times more likely than non-binge drinkers to report unprotected and unplanned sex, legal or criminal problems, and being hurt or injured as a result of their drinking.

There is also evidence that college males are at greater risk of alcohol-related problems than women. Among young adults (18-25 years old) men are two times more likely to meet criteria for an Alcohol Use Disorder than young women (Grant, Dawson, Stinson, Chou, Dufour, & Pickering, 2004). Specifically among college students, men

report more heavy drinking days (Seo & Li, 2009) and related problems compared to college women (Hingson, Heeren, Winter, & Wechsler, 2005; White, McMorris, Catalano, Fleming, Haggerty, & Abbott, 2006). Considering the possible dose and gender effect of alcohol consumption on related problems, it is clinically relevant to consider the factors influencing college males' decision to continue drinking after a drinking episode has been initiated.

Priming Effect

It has been proposed that initial consumption of certain substances increases motivation, or desire, to consume more of that substance (Stewart, de Wit, & Eikelboom, 1984; de Wit, 1996; Rose & Duka, 2006). This increase in motivation after a single dose of a drug is known as the priming effect. This effect was first studied in squirrel monkeys that were trained to self-administer amphetamine by lever pressing (Gerber & Stretch, 1973). Once self-administration of amphetamine became reliable, lever pressing was followed by injections of saline; therefore, the lever pressing was no longer reinforced by a dose of amphetamine. Over time lever pressing diminished to an absent or low rate, suggesting operant extinction as the previously reinforced lever pressing no longer resulted in a dose of amphetamine. After lever pressing was extinguished, the monkeys were administered non-contingent doses of amphetamine that did not follow lever pressing. After the non-contingent administrations, the monkeys reinstated lever pressing that was characteristic of the pattern of drug self-administration that was observed during the trials when a dose of amphetamine was produced as a direct consequence of lever pressing. The results suggest that exposure to a substance identified as a reinforcer may reinstate previously reinforced self-administration behavior.

Increased drug seeking and taking behavior may be reflective of enhanced motivation for that reinforcer.

Reinstatement of drug taking behavior and increased motivation for a drug may result from exposure to an environment similar to the one in which substance use has been reinforced. The environment under which unconditioned and conditioned stimuli result in increased behavior to obtain, or preference for, a drug is well explained in the classical conditioning literature (Bouton & Swartzentruber, 1991; Carroll & Comer, 1996). The environment in which drug-related behavior has been previously reinforced may function as an establishing operation for substance use, bringing substance use under stimulus control (Bickel & Kelly, 1988). Additionally, internal states such as the pharmacological effects of the drug may also increase drug-seeking and –taking behavior due to prior pairings with those experiences and reinforcer delivery (Baker, Steinwald, & Bouton, 1991). That is, if a participant experiences a physiological sensation that is similar to intoxication, those sensations may serve as cues of the increased likelihood of reinforcer delivery and the participant may engage in increased drug-related behavior. However, not all people who have consumed a substance established as a reinforcer engage in increased drug-seeking and –taking behavior. Furthermore controlled drinking has been postulated as a safe and appropriate pattern of behavior, even among those with a history of alcohol dependence (Marlatt, 1983). To better understand the priming effect, and particularly who is at increased risk for enhanced motivation to drink after consumption had been initiated, laboratory studies with humans have been conducted.

Priming Studies with Human Participants

Priming studies with humans have primarily studied alcohol consumption (de Wit, 1996). One of the first studies to measure a priming effect with human participants trained participants to button press to receive alcohol (Ludwig & Wikler, 1974). Participants were 24 males at a Veterans Administration Hospital who recently completed detoxification from alcohol. Each participant participated in three sessions in which they were given a preload of either a high (1.2ml/kg), low (0.6 ml/kg), or placebo dose of alcohol. Half the participants completed the priming sessions in a labeled environment, in which a bottle of their alcohol of choice was present in the testing room and button pressing resulted in a dose of their alcohol and mixer of choice. Participants in the non-labeled condition completed the testing sessions in a room with a bottle of water and button pressing resulted in a predetermined alcohol and mixer dose. Each participant consumed one preload dose per session and consumed all three preloads across three testing sessions. After consuming either of the two alcohol preloads, participants reported elevated craving for alcohol and performed more button presses. The priming effect was strongest in the labeled environment. Similar results were found among chronic alcoholics who rode a stationary bicycle to obtain alcohol (Bigelow, Griffiths, & Liebson, 1977). A high (77.7gm) and a low (33.3gm) preload were given to participants. After receiving both preloads of alcohol, participants rode for greater amounts of time in exchange for more alcohol. These studies support a priming effect of alcohol consumption among alcoholics.

Support for a priming effect has not been observed in all studies. Engle and Williams (1972) administered a rating scale of desire to 40 alcoholics after they

consumed a preload. All participants received a drink and for half of the participants their drink contained an ounce of alcohol. Among the participants who were given a dose of alcohol. half of them were told that their drink contained alcohol but the other half were not told that the drink contained alcohol, although it did. Among the participants who were given a drink containing no alcohol, half were told that the drink contained alcohol although it did not. Participants who consumed alcohol and were told so reported a significant increase in desire for alcohol; however, when given the opportunity to request additional drinks only one participant did so. Participants who consumed alcohol but did not expect to did not report increased desire to drink, nor did participants who consumed a drink that did not contain alcohol. Results suggest that expectancies may influence desire to drink, as those who expected to consume alcohol, and did, endorsed enhanced desire to drink but participants who did not consume alcohol, or consumed alcohol but did not expect to, did not report increased desire. The findings imply that the expectation to consume alcohol moderated the effect of an alcohol preload on desire to drink. Additionally, the results do not suggest that increased desire to drink necessitates further drinking, implying that consumption of alcohol and increased desire for alcohol do not solely account for alcohol seeking behavior.

Additional studies have provided further evidence that consumption of a priming dose may not be a sole determinant of further consumption. Marlatt et al. (1973) found that among alcoholics and social drinkers, preload condition did not significantly account for amount of beverage consumed but expectation of whether the preload contained alcohol did (Marlatt, Demming, & Reid, 1973). Results of this study suggest that the priming effect, including the physiological effects of alcohol, does not entirely account

for an increase in drinking behavior. Additionally alcoholics in an environment with work-contingent alcohol administration alternated between days of work, during which they abstained from alcohol, and days of heavy drinking (Mello & Mendelson, 1965). These results suggest that drinkers do not lose control of their drinking after consumption has been initiated, implying that factors in addition to the priming effect may account for repeated and heavy alcohol use.

In an attempt to account for variability in hazardous alcohol consumption, additional priming studies have assessed for variability in the effect among different types of drinkers and environments. Hodgson, et al. (1979) conducted a priming study with 20 participants (6 female) identified as either moderate or severe (dependence symptoms for six or more months) alcoholics (Hodgson, Rankin, & Stockwell, 1979). In their study they measured self-reported desire to drink, as well as speed in which participants consumed alcohol after receiving a high (150 ml), low (15 ml), or placebo preload of alcohol. Among participants classified as severely alcoholic, reported desire to drink and speed in which they consumed subsequent drinks were elevated compared to moderate alcoholics and both significantly increased after the high alcohol priming dose; however moderate alcoholics speed of drinking significantly decreased between the placebo and high priming dose. The results suggest that the priming effect increases motivation to drink among certain drinkers but not all. Additionally, considering that the severely alcoholic participants displayed the greatest priming effect, sensitivity to preloads may partly account for risk of engaging in hazardous use.

Priming Studies with Non-Alcoholics

Whereas early priming studies utilized human participants identified as alcoholics, later studies have assessed for a priming effect among social drinkers. In the first priming study with non-alcoholic participants, drinkers who consumed 4-18 drinks per week were asked what was the least amount of money they would choose over alcohol on a choice procedure (de Wit & Chutuape, 1993). During later sessions participants were given a high (0.5g/kg), low (0.25 g/kg), or placebo preload of alcohol. After the high and low preload, participants reported increased desire to drink and they were more likely to choose another drink of alcohol over the amount of money they had previously stated as being preferred over alcohol. This study provides evidence that preloads increase social drinkers' motivation to consume more alcohol as well as the increased reinforcing efficacy of alcohol after consumption of a preload.

In a second study assessing for an alcohol priming effect among social drinkers (3-24 drinks per week), participants were instructed to respond on two concurrent random-ratio schedules after consuming a preload (0.25 g/kg, 0.5 g/kg, or placebo) (Chutuape, Mitchell, & de Wit, 1994). Each participant consumed a placebo preload twice and the high and low alcohol placebo once across four testing sessions. One random-ratio schedule was to earn money and the second schedule was to earn alcohol. The distribution of responding between each schedule of reinforcement was interpreted as an indicator of preference for the reinforcer, as well as response cost and preference for alternative reinforcers (i.e. money or alcohol). Participants responded more on the alcohol schedule when the probability of earning money was low, as well as after being primed with alcohol. No differences in responding were observed between the two

alcohol preload conditions. Participants also reported greater desire to drink 30 minutes after consuming both preloads and 60 minutes after consuming the high preload. Results suggest that preference for alcohol, as measured by greater responding on the alcohol schedule, increased after being primed with alcohol and when the probability of obtaining an alternative reinforcer is low.

Studies with social drinkers have also assessed for individual differences that may account for variability in the alcohol priming effect. In one study, after one of three different alcohol preloads (0.2, 0.4, 0.8 g/kg) all participants (N=12) reported an increased desire and liking for alcohol; though no difference in preference for alcohol was observed on a choice task to earn points in exchange for money or alcohol (Kirk & de Wit, 2000). However, participants who endorsed the greatest increase in positive mood after the high alcohol preload (0.8 g/kg) displayed an increased preference for alcohol over money on the choice task. The results of this study suggest that the priming effect may be strongest in individuals who experience greater subjective positive mood effects from ethanol.

Further evidence has been collected to suggest that subjective differences in alcohol effects account for variability in alcohol consumption. One study comparing light (5≥ drinks per week and no binge episodes; N=14) and heavy drinkers' (10≥ drinks per week and 1≥binge episode a week; N=20) response to alcohol found that heavy drinkers endorsed greater stimulating and less sedative effects of alcohol than light drinking participants (King, Houle, de Wit, Holdstock, & Schuster 2002). Further, the heavy drinking participants in the study had a weaker cortisol response to alcohol than light drinkers. It is unknown whether the differences in response to alcohol in this study

predated the establishment of drinking patterns or are the consequence of different drinking histories; however, the results do suggest that heavy drinkers are less sensitive to sedative alcohol effect. Thus, heavy drinkers may be at increased risk of harmful alcohol consumption due to greater sensitivity to the positive stimulating effects of alcohol and greater tolerance to the sedative effects of alcohol.

In a second biphasic alcohol response study, an alcohol priming effect was measured by increased urge to drink after an alcohol, but not placebo, preload; additionally, differences in reported alcohol effects between binge and non-binge drinkers were measured (Rose & Grunsell, 2008). Binge drinkers were less sensitive to the sedative effect of alcohol than non-binge drinkers; however binge drinkers did not display elevated levels of inhibition at baseline or after an alcohol preload. This study implies that personality differences such as impulsiveness may not account for increased use, but that insensitivity to the aversive effects and sensitivity to the positive effects of alcohol do. Results suggest that heavy drinkers may not be sensitive or aware of the aversive effects of alcohol consumption. Considering the variability in alcohol effects between different types of drinkers, it may be that alcohol drinking motives also discriminate which drinkers exhibit sensitivity to alcohol priming effects. It appears valuable to further study what individual differences account for heightened risk of increased motivation to drink after consumption has been initiated.

Alcohol Drinking Motives

Drinking motives are the different reasons that compel someone to drink and thus represent the different functions that alcohol can serve for a person. A motivational model of alcohol use does not consider motives to be the sole factor in determining

alcohol use, but rather motives are associated with unique antecedents and consequences. Motives are shaped by past experiences with drinking (i.e. past reinforcement, punishment, social modeling), the current environment (both internal and external) and alcohol expectations (Carpenter & Hasin, 1998). Cox and Kilinger (1988, 1990) postulated two dimensions that can categorize drinking motives, the valence and source of motivation. That is drinking can serve as a positive or negative reinforcer and the source of the desired outcome can either be internal or external. For example, a person can drink to achieve or enhance a desired outcome (positive reinforcement) or to avoid or rid oneself of an undesired outcome (negative reinforcement). Additionally, an individual may drink to manage internal states and rewards such as emotional or physiological states, or to manipulate external social reinforcers. Moreover, across those two dimensions, four categories of drinking motives are identified:

> "(a) internally generated, positive reinforcement motives (drinking to enhance positive mood or well-being- enhancement), (b) externally generated, positive reinforcement motives (drinking to obtain positive social rewards- social), (c) internally generated, negative reinforcement motives (drinking to reduce or regulate negative emotions- coping), and (d) externally generated, negative reinforcement motives (drinking to avoid social censure or rejection- conformity)." (page 118; Cooper, 1994)

Previous priming studies provide evidence that alcohol consumption is a voluntary act influenced by a variety of different factors and that some, but not all, individuals experience increased motivation to drink after consuming alcohol. Therefore, alcohol consumption and the effects of a priming dose may be best conceptualized within

a motivational model, in which sobriety or intoxication is the result of a decisional framework influenced by the drinker's motivation for an expected reinforcer (Cox & Klinger, 1988).

Drinking Motives & Reinforcing Value of Alcohol

A study with college students tested whether affect and coping motives influenced the reinforcing value of alcohol (Rousseau, Irons, & Correia, 2011). Rousseau et al. (2011) randomized 44 college students, who endorsed drinking in the past month, to one of two mood induction conditions: negative and neutral affect. A mood manipulation check was performed and measured a significant increase in negative affect in the negative, but not the neutral, mood condition. The choice task was completed immediately after the mood induction procedure; the available reinforcers were monetary values ascending from $0 to $20 and "up to two 12 ounce beers, two 5 ounce glasses of wine, or two mixed drinks with each containing 1 ounce of alcohol." Results demonstrated that the price at which participants first chose money over alcohol was predicted by coping motives, the mood-induction condition, and an interaction term between condition and coping motives. Further analyses revealed that there was a significant difference in preference for alcohol over money between participants in the negative mood condition who endorsed low or high coping motives. However, the difference in preference for alcohol among low and high coping motives participants in the neutral mood condition was not statistically significant. Thus the authors of the study concluded that the results did not support mood influencing the reinforcing value of alcohol for all participants, but negative mood did significantly increase crossover points in individuals who endorsed higher levels of drinking to cope. Considering the influence

of motives on the reinforcing value of alcohol, it may be informative to assess whether drinking motives, increased positive mood after drinking, and drinking effects (sedative or stimulant) account for differences observed in the choice to continue drinking after consumption has been initiated.

Choice Procedures

The reinforcing value of alcohol can be quantified with choice procedures that measure under which conditions alcohol is preferred (Vuchinich & Tucker, 1988). Several choice procedures are based on a behavioral economic conceptualization of choice behavior. Behavioral economics posits that preference for a reinforcer varies as a function of cost-benefit analyses; specifically, preference varies as a function of constraints on that reinforcer and the availability of other reinforcers (Vuchinich & Tucker, 1988). The impact of constraints is related to the matching law, which states that the amount of engagement in a specific behavior by an organism is proportionally related to the amount of reinforcement that follows that behavior (Herrnstein, 1970). The law suggests that an organism will engage in a small amount of a behavior when it is followed by at least a small amount of the reinforcer; further, an organism is expected to emit greater proportions of that behavior only if the behavior is followed by a greater amount of the reinforcer. Therefore, if constraints are placed on the reinforcer by requiring a greater emission of a behavior before it will be presented, it is anticipated that over time the behavior will decrease in frequency and the organism will reallocate its energy and resources toward alternative reinforcers that have greater efficiency.

A demand curve is the relationship between the "cost" of the reinforcer (e.g. money, time, work) and the magnitude of the reinforcer (Hursh, 2000). Initially as the

cost of the reinforcer rises there is little, if any, change in the amount of reinforcer consumed; however, at a crossover point there is a decrease in consumption relative to the rise of the cost. This point varies for each reinforcer, as well as between organisms. Elasticity of demand is the rate at which consumption decreases relative to the initial level of consumption. Inelastic demand is when consumption increases or maintains stable with increasing cost. For all reinforcers there is a crossover point when consumption becomes elastic if the cost becomes high enough (Hursh, 2000). Thus the demand curve is characterized by two slopes: the initial shallow slope at low costs when consumption is relatively inelastic and a steep slope at high costs when the decrease in consumption is proportionally larger than the increase in cost and demand has become elastic (Bickel, Marsch, & Carroll, 2000).

The second variable behavioral economics theory posits as important in determining reinforcer value is the availability of other reinforcers and the constraints on access to them. The theory proposes that consumption of alcohol is partly controlled by the variety of different reinforcers in the environment and the response cost and availability of those reinforcers. The clinical utility of behavioral economics theory is its focus on predicting the conditions under which alcohol intoxication will be highly preferred and valued more than alternative reinforcers. This focus allows researchers and clinicians to study the possible establishing and abolishing operations that influence drug reinforcement. Within this theory, alcohol consumption entails a series of "distributed choices," such that an organism's substance use is not determined by one behavior or choice but rather a collection of multiple choices (Murphy, Correia, & Vuchinich, 2009).

Although previous priming studies have utilized choice procedures none have utilized a standardized and empirically validated procedure.

The Multiple Choice Procedure

One choice procedure that has been validated with college students (Benson, Little, Henslee, & Correia, 2009; Little & Correia, 2006; Rousseau et al., 2011) to measure the reinforcing value of alcohol is the Multiple Choice Procedure (MCP; Griffths, Troisi, Silverman, & Mumford, 1993). The MCP arranges a series of discrete choices between a dose of alcohol and escalating amounts of money and delivers intermittent reinforcement for the choice behavior. Participants complete a multiple-choice questionnaire and for each choice are prompted to choose one of two potential reinforcers (e.g. alcohol vs. money). After completing the questionnaire one choice is randomly selected and reinforced (Griffths et al., 1993). The MCP measures the relative reinforcing value of alcohol by the crossover point, which is the monetary value at which participants first choose the money choice over a dose of alcohol.

The MCP has been shown to be sensitive in measuring reinforcement as a function of reinforcer magnitude, extinction, and drug deprivation and satiation (Griffiths, Rush, & Puhala, 1996). Since its inception the MCP has been used with a variety of different drugs including: pentobarbital (Griffiths et al., 1993), nicotine (Griffiths et al., 1996) caffeine (Garrett & Griffiths, 1998), marijuana (Greenwald & Stitzer, 2000), cocaine (Jones, Garrett, & Griffiths, 1999), MDMA (Tancer & Johnson, 2007), and alcohol (Benson et al., 2009; Little & Correia, 2006; Rousseau et al., 2011).

The efficiency of the MCP is advantageous in that a series of choice situations can be evaluated in one session, while more traditional methods of alcohol reinforcement

require repeated sessions, as well as greater access to reinforcers. In other words, a single MCP session can be used to assess the reinforcing value of multiple doses of alcohol relative to a range of alternative reinforcers. Additionally, most typically developing adults have a stable and long history of making financial-based choices. The use of money as a competing operant in the MCP utilizes a reinforcer that does not require a training session to acquaint the participants to the reinforcer. Further, the crossover point, when the participant first chooses money over alcohol, has a real-world value that can be easily interpreted in terms of reinforcement.

Among college students the MCP has displayed sensitivity to the effects of reinforcer magnitude (6 ounces vs. 12 ounces of alcohol; 1 vs. 2 vs. 3 standard servings of alcohol) and constraints (delay) on an alternative reinforcer (money) (Little & Correia, 2006; Benson et al., 2009). Little & Correia (2006) used both a laboratory version with a reinforcement session, and a hypothetical version of the MCP, in which participants completed a computerized version of an MCP questionnaire that was not followed by a reinforcement session. Under both conditions the MCP crossover points were associated with alcohol consumption (frequency and quantity) and alcohol-related problems, and crossover points were higher if the monetary reinforcer was delayed.

Rousseau et al. (2011) published the first MCP study to investigate the relationship between mood, alcohol motives, and the reinforcing efficacy of alcohol among college students. Although the MCP was developed to test environmental effects on drug reinforcement, this study measured how internal factors (i.e. affect and coping motives) influence the relative reinforcing value of alcohol, suggesting that the MCP can be used to study both internal and external factors related to drug reinforcement.

Considering previous research that suggests that drinking motives account for variability in initiation of alcohol consumption, it appears valuable to test whether drinking motives also account for the magnitude of the priming effect.

Current Study

Previous research has supported an alcohol priming effect among social drinkers; however, the magnitude of the effect varies greatly across participants and previous studies have not employed a standardized choice procedure. The purpose of the current study is to inform this area of research in a controlled laboratory setting using a validated choice procedure among at-risk binge drinking college males. It has been suggested that greater endorsement of certain drinking motives, positive mood after drinking, and specific alcohol effects account for differences in the reinforcing value of alcohol; however, no study to date has measured whether these variables account for differences observed in the choice to continue drinking after consumption has been initiated. In the current study, a college sample was screened for males who are at least 21 years old and engaged in a binge episode (≥5 standard drinks in one seating; Wechsler et al., 1995) within the last month. A sample of binge drinking men were used, as the study intended to assess for the factors related to the reinforcing value of alcohol in a sample of at-risk drinkers. Participants completed a variety of measures online, including measures of drinking patterns, drinking motives, and demographics. Participants who met inclusion criteria were invited to attend two laboratory sessions, during which they were randomly assigned to one of two preload conditions: alcohol or placebo. During each laboratory session participants completed the MCP, as well as measures of their current affect, desire to drink, and subjective alcohol effects to determine the reinforcing value of

alcohol after the preload procedure. The same procedures were conducted during a second laboratory session; however, participants were administered the preload condition (alcohol or placebo) that he did not consume during the first session. The order of preload condition was counterbalanced across participants. Based on past research, our primary hypothesis was that individuals would endorse a greater reinforcing value of alcohol after consuming an alcohol preload relative to a placebo preload. The MCP, and more specifically the crossover value (when an individual first chooses money instead of alcohol), served as the primary measure of reinforcing value. Self-reported desire to drink served as a second measure of the reinforcing value of alcohol. Considering the restraints of a laboratory study, it was also hypothesized that external drinking motives (i.e. social and conformity) would not be associated with the priming effect, as all participants completed the laboratory procedures on their own; however, a stronger priming effect was expected in participants endorsing greater coping and enhancement motives, as evidenced by a significantly higher crossover point in the alcohol preload condition than in the placebo condition. Additionally, participants who reported greater positive affect after the alcohol preload, compared to the placebo preload, were expected to exhibit a greater priming effect than participants who report little or no difference in positive mood. Lastly, it was hypothesized that participants who endorse greater stimulating, rather than sedating, effects of alcohol after the preload will exhibit a stronger priming effect.

METHODS

Participants

Screening Survey

A total of 99 undergraduate males from a large public university completed the online screening survey. This sample consisted of males at least 21 years old, with a mean age of 22.14 years old (SD= 2.26; range= 21-34). The majority of participants who completed the survey were not members of a fraternity (69.4%). All of the participants identified as being Caucasian (100%) and the majority recorded their ethnicity as Non-Hispanic/Latino (99%); though, other racial categories were also represented in the sample (African American = 4; 4%, Asian = 3; 3%, Native American or Alaska Native= 2; 2%, Other= 3; 3%). Percentages for racial categories sum to greater than 100% because participants could endorse multiple categories. The majority of participants (93.9%; N=93) was recruited from under undergraduate psychology courses and thus received one hour of extra credit for completing the survey portion of the study. The remaining participants (3.03% N=3) were recruited via email advertisements that were sent to student organizations and were given $10 after completing the survey and laboratory portion of the study.

On average participants reported drinking about 13 drinks per week (M= 12.62; SD= 13.23; range= 0-58), endorsed about 4 binge episodes in the past month (M= 3.53; SD= 4.58; range= 0-17) and an average Rutgers Alcohol Problems Index (RAPI) score of 29 (M= 28.78; SD= 7.82) for the 28 days prior to completing the screening survey. Each of the four assessed motives for alcohol use were endorsed; however, paired samples t-tests revealed that some motivations were endorsed significantly more than others (all

paired samples tests were significant, with mean differences ranging from 1.76 to 7.87, all p's<0.01). Social motives were significantly more likely than any other motive to be endorsed (mean=14.21, SD=5.66), followed by enhancement motives (mean=11.48, SD=4.75), coping motives (mean=8.10, SD= 3.23), and conformity motives (mean=6.35, SD=1.83).

Laboratory Sessions

In order to meet inclusion criteria for the laboratory portion of the study, a participant needed to endorse on the screening survey at least one binge episode in the prior 28 days. These criteria were used to ensure that the participant had consumed the ceiling amount (two drinks) available in the lab portion of the study at some point during the prior 28 days and to maintain a focus on participants who engaged in high-risk drinking. Exclusion criteria included current use of prescription drugs or any physical or psychological conditions that are adversely impacted by alcohol. These exclusions were enacted to prevent any unforeseen or unaccounted for interactions between the prescription drug, preexisting conditions, and alcohol. Of the 99 participants that completed the survey portion of the study, 47 individuals qualified for the laboratory portion. The majority was recruited from psychology courses (95.7%; N=45), though two were recruited from campus-wide student organizations (4.26%, N=2). For the laboratory study, 21 qualified individuals participated after receiving an invitation via email; however, one participant only completed the first laboratory session after failing to attend his second scheduled session. Therefore, only 20 participants completed both lab sessions. The majority of participants who completed the laboratory portion were

recruited from psychology courses (90%; N=18) and two were from student organizations (10%, N=2).

In regards to demographics, there were no significant differences between the 21 lab participants and the overall 99 individuals in the survey sample. Similar to the survey sample, the mean age was 22.14 years old (SD= 2.78; range= 21-34) for laboratory participants. Additionally, the majority were not members of a fraternity (63.6%). All of the participants who completed the laboratory portion of the study identified as being Caucasian (100%) and recorded their ethnicity as Non-Hispanic/Latino (100%), with other racial categories represented (Asian = 1; 4.5%, Native American or Alaska Native = 1; 4.5%; Other = 2; 9.1%). The order of lab condition was counterbalanced across all of the participants, so that of the 20 individuals who completed both laboratory sessions, 10 individuals were randomly assigned to the alcohol preload condition for the first session and 10 participants were assigned to the alcohol condition for their second session.

Laboratory participants reported drinking an average of 19 drinks per week (M= 18.7; SD= 9.8; range= 1-38), endorsed over 6 binge episodes (M= 6.5; SD= 5.3; range= 1-16), and an average RAPI score of 32 (M= 31.86; SD= 7.44) for the 28 days prior to completing the screening survey. Each of the four assessed motives for alcohol use were endorsed by laboratory participants; however, similar to the results found across the entire survey sample, paired samples t-tests revealed that some motivations were endorsed significantly more than others (all paired samples tests were significant, with mean differences ranging from 2.41 to 9.19, all p's<0.03). Social motives were significantly more likely than any other motivation to be endorsed (mean=15.62,

SD=4.68), followed by enhancement motives (mean=12.73, SD=4.47), coping motives (mean=8.77, SD=2.98), and conformity motives (mean=6.36, SD=1.62).

The endorsement of drinking variables between laboratory and non- laboratory participants was significantly different, as laboratory participants endorsed greater binge episodes [t(27)=3.06, p=.005], average drinks consumed per week [t(88)=2.47, p=.015], and RAPI scores [t(96)=2.14, p=.035] in the prior 28 days, than participants who did not participate in the laboratory sessions. No differences were observed in demographic variables and endorsement of drinking motives. The 21 lab participants were compared to the 26 participants who were invited to complete the laboratory sessions but did not choose to participate. No significant differences between the two groups were observed for demographic variables, pattern of drinking consumption, negative drinking consequences, or drinking motives, suggesting that the students who participated in the laboratory study did not significantly differ from participants who met inclusion criteria but did not participate in the laboratory portion of this study.

Measures

Demographic questionnaire. Participants completed a brief demographic questionnaire. The questionnaire included gender, age, weight, number of school years completed, affiliation with the Greek system, and ethnicity. Additionally, participants were asked if they had any physical or psychological conditions that are adversely impacted by alcohol and if they take any prescription medication daily. These questions were used for exclusion purposes.

Daily Drinking Questionnaire (DDQ; Collins, Parks & Marlatt, 1985*)* is an open-ended calendar on which participants reported the average number of drinks they

consumed for each day of the week for the 28 days prior to completing the study, in addition to the amount of time they spent drinking on those days. Additionally, participants reported the number of binge episodes they engaged in during the prior 28 days. A binge episode was defined as 5 or more drinks on one occasion (Wechsler et al., 1995).

Rutgers Alcohol Problems Index (RAPI, White & Labouvie, 1989*)* is a 23-item screening measure that assesses the frequency of alcohol-related problems among adolescents and young adults. The original version of the scale assessed for frequency of problems across the last three months. A modified version of the scale was used in this study to assess the current frequency of alcohol-related problems over the past 28 days. Responses were scored on a 5-point Likert scale, from '*none'* (0) to '*over 10 times'* (4). In the current sample, internal consistency of this scale was excellent (Cronbach's α=.92).

The Multiple Choice Procedure (MCP) is a method used to measure drug reinforcement by assessing choice behavior leading to drug administration (Griffths et al., 1993). The MCP was originally used to study the reinforcing value of pentobarbital (Griffiths et al., 1993) but has since been used to research marijuana (Greenwald & Stitzer, 2000), cocaine (Jones et al., 1999; Lile, Stoops, Glaser, Hays, & Rush, 2004), pentobarbital (Griffiths et al., 1993), caffeine (Garrett & Griffiths, 1998), nicotine (Griffiths et al., 1996; Jones et al., 1999), MDMA (Tancer & Johnson, 2007) and alcohol (Little & Correia, 2006; Rousseau et al. 2011). The MCP consists of two primary steps: (1) participants complete a multiple-choice questionnaire that consists of a predetermined number of choices between varying amounts of money and a set amount of the substance of study, and for each choice participants are required to choose one of the two potential

reinforcers (i.e. substance vs. money choice); secondly (2) one choice from the multiple-choice questionnaire is randomly selected and reinforced (Griffths et al., 1993). In the MCP not every choice is reinforced but rather choice behaviors are intermittently reinforced. In the present study a 41-item version of the MCP was used, consisting of 41 choices between varying amounts of money and a 12-ounce beer. The procedures section will discuss the administration of the MCP in further detail.

The *Drinking Motive Questionnaire Revised* (DMQ-R) (Cooper, 1994) is a 20-item measure that assesses how frequently a participant drinks for a given reason. The measure was developed to assess for two dimensions of drinking motives (i.e. source and valence); therefore, the questionnaire measures four categories of drinking motives: drinking to reduce or regulate negative emotions (coping), drinking to enhance positive mood or well-being (enhancement), drinking to obtain positive social rewards (social), and drinking to reduce social-generated stress (conformity). Participants were instructed to consider how frequently they drink for each reason. Responses were scored on a 5-point Likert scale, ranging from '*Almost never/never*'(1) to '*Almost always/always'* (5). Each subscale (coping motives Cronbach's α=.78, enhancement motives Cronbach's α=.83, social motives Cronbach's α=.91, and conformity motives Cronbach's α=.59) ranged from acceptable to excellent.

The *Desires for Alcohol Measure Short-form* (DAQ) (Clark, 1994; Love, James, & Wilner, 1998) was utilized to measure alcohol cravings and urges. The DAQ contains14 items and assesses intention to drink alcohol, desire to consume alcohol, anticipation of positive outcomes from drinking, and anticipation of relief of negative affect or alcohol withdrawal. This measure is scored on a 7-point likert scale ranging

from '*not true at all right now'* (1) to '*extremely true right now'* (7). In the current sample, internal consistency of this scale was good (Cronbach's α=.79 for the alcohol laboratory condition, and .68 for placebo condition).

The *Positive and Negative Affect Scale* (PANAS) is a 20-item self-report measure of affect (Watson, Clark, & Tellegen, 1988). The PANAS is composed of two 10-item scales, one scale measures positive affect and the other measures negative affect. The positive affect scale measures enthusiasm, alertness, and engagement in positive experiences. The negative affect scale measures subjective distress and unpleasurable experiences. Participants rated the extent to which they were experiencing different emotions on a 5-point likert scale, with responses ranging from '*very slightly or not at all'* (1) to '*very much'* (5). This measure was used to assess the emotional states of participants after the preload administration. In the current sample, internal consistency of this scale was good for the subscale measuring positive affect across the two conditions (alcohol condition Cronbach's α=.91; placebo condition Cronbach's α=.87). However, the subscale measuring negative affect exhibited good internal consistency in the placebo condition (Cronbach's α=.82) but not in the alcohol condition (Cronbach's α=.31).

The *Biphasic Alcohol Effects Scale* (BAES; Martin, Earleywine, Musty, Perrine, & Swift, 1993) is a 14-item scale that was developed to measure the subjective stimulating and sedating effects of alcohol among college students. This measure is scored on a 11-point Likert scale ranging from '*not at all'* (0) to '*extremely'* (10). The scale consists of two subscale: stimulation and sedation. The stimulation subscore was computed by summing the scores for the following items: elated, energized, excited,

stimulated, talkative, up, and vigorous. The sedation subscore is the sum of the scores for items: down, heavy head, difficulty concentrating, inactive, sedated, slow thoughts, and sluggish. In the current sample internal consistency of each subscale (sedating effects in alcohol condition Cronbach's α=.81, stimulating effects in the alcohol condition Cronbach's α=.95, sedating effects in the placebo condition Cronbach's α=.89, and stimulating effects in the placebo condition Cronbach's α=.93) ranged from good to excellent.

Alco-Sensor IV. A handheld portable breath alcohol instrument was used to measure participant's BAC throughout the laboratory sessions. The instrument measures breath alcohol between 0.000-0.400 BAC. This instrument is approved by the National Highway Traffic Safety Administration and meets criteria for evidential use by law enforcement for in-field alcohol testing (Intoximeters Inc, 1995).

Procedures

Survey

The majority of survey participants were recruited through an online research system offered through a psychology department at a large southeastern university and was made available to undergraduate psychology and statistics students. The screening survey was used to identify participants who met the inclusion criteria for this study. Participants completed an online screening survey that included an informed consent, the demographic questionnaire, DDQ, RAPI, and DMQ.

Participants who met the inclusion criteria were contacted via e-mail within three weeks of completing the screening survey to participate in two laboratory sessions for an additional six extra credit hours (three hours per laboratory study) and to be included in a

raffle for $50. The email informed participants that the laboratory sessions may involve the consumption of alcohol and that they may earn up to $20 during each laboratory session. Invited participants were asked to refrain from any recreational drug or alcohol use 24 hours before their scheduled session and to fast from eating for four hours immediately prior to the laboratory session.

Due to the low interest and number of participants meeting inclusion criteria for the study in Psychology courses, recruitment was expanded to the general student body. Presidents of student organizations were contacted to send a recruitment email to the males in their organization that included a link to the online screening survey that was identical to the one completed by students recruited through the Psychology department. Participants who met the inclusion criteria were contacted via e-mail within three weeks of completing the screening survey to schedule the two laboratory sessions for $10 and to be included in the raffle for $50 after completing the second laboratory session. The email also informed participants about the possibility that laboratory sessions may involve the consumption of alcohol, that they may earn up to $20 during each laboratory session, to refrain from any recreational drug or alcohol use 24 hours before their scheduled session and to not eat for four hours immediately prior to the laboratory session.

Laboratory

Each laboratory session consisted of one participant and two experimenters. Upon arrival to the lab, the consent form was reviewed with each participant by experimenter one, instructing participants that they may withdraw from the study at any time but are required to remain in the laboratory for at least one hour after completing the

MCP, regardless if he did or did not consume alcohol. Participants were informed that the laboratory sessions typically last two and one-half hours but that they will need to remain in the laboratory until his BAC reaches .002 or less, which may require more than two and one-half hours. Participants were also required to bring a form of identification to verify their current age and were asked to not bring schoolwork with them. It was then verbally confirmed that participants did not have any psychical or psychological conditions that are adversely affected by alcohol and that they abstained from any recreational drug use, aside from tobacco products, in the last 24 hours. If a participant endorsed using a tobacco product in the past 24 hours, the amount of time since his last use was documented. Four laboratory participants reported using a tobacco product within 24 hours before both laboratory sessions, none of which appeared to be in withdrawal at the time of the laboratory sessions nor did they ask to use a tobacco product during their laboratory sessions. For safety considerations, all participants were given a breathalyzer test to confirm that they had no alcohol in their system. No participants provided evidence of current alcohol intoxication or recent drug use. A new removable, disposable mouthpiece on the breathalyzer was used to ensure each participant had a sterile one.

Preload.

During each session participants were administered one of two preload beverages – either alcohol or placebo – in an order based on prior random assignment. Growlers and beer were used for the preload administration, as beer has been found to be the most preferred alcoholic beverage among young adults (Lanier, Hayes, & Duffy, 2005) and there is evidence that non-alcoholic beer and beer are the most effective placebo and

alcohol counterparts (Keane, Lisman, & Kreutzer, 1980). Participants in the alcohol condition were administered .22 ml/kg of light beer. Individuals in the placebo condition consumed .22 ml/kg of non-alcoholic beer. The preload was measured and poured into an opaque growler by experimenter two. Experimenter one, who did not know the preload condition, poured the preload equally into three cups, so that each portion could be consumed at a rate of one portion over 5 minutes. The participant and experimenter one, who reviews the consent form and administers the preload and post-preload packet, were blind to the preload condition. Twenty minutes after the preload administration experimenter two measured the participants' BAC and experimenter one immediately administered the post-preload packet, which included the DAQ, BAES, PANAS, and the Multiple Choice Procedure (MCP).

The average BAC twenty minutes after the participant consumed the entire alcohol preload was .022 g/mL. (SD=.009). The targeted BAC increase was .015-.02 g/mL. No significant difference was observed between the upper range of the targeted BAC increase and the observed BAC ($t(19)=1.22$, $p=.24$). No univariate outliers were identified for post-alcohol preload BAC. Additionally, the final six laboratory participants completed a questionnaire at the end of the second session documenting whether he believed he consumed alcohol during the first and second session. One half (3) of the participants accurately estimated which session he consumed alcohol and which session he did not consume alcohol. The other half (3) estimated incorrectly and believed that he consumed alcohol during the placebo condition. The inquiry in the post-preload packet about the participant's belief of whether he was administered alcohol was included to demonstrate if the expectancy manipulation was credible (Rohsenow & Marlatt, 1981).

However, due to experimental error this manipulation check was not completed with all participants.

The MCP instructed participants to choose between "one 12 ounce beer " and 41 escalating monetary values. Each choice option was assigned a number and the money choice ascended from $0 to $20 in 50 cent increments, while the alcohol choice remained at "one 12 ounce beer" for each item. After completing the post-preload packet participants drew a number between1 and 41. Participants then received their choice on the MCP that corresponds with the number drawn (e.g., Choice number 15, indicated that the participant should receive either one 12-ounce beer or $7.00. If on the MCP form, the participant circled "one 12-ounce beer," he was offered one 12-ounce beer). When the randomly drawn choice indicated alcohol, the participant was immediately provided with a 12-ounce beer and he was given 15 minutes to consume as much of the beer as he wished. When the choice indicated preference for money, the chosen monetary amount was delivered immediately.

The laboratory was equipped with a chair, a desk, and a computer with Internet access. Snacks and non-alcoholic beverages were also available. All participants, including those who did not consume any alcohol, were required to stay in the lab for at least one hour after completing the MCP. This requirement was instituted to ensure that participants did not select money for the sole reason of leaving the laboratory sooner. After the hour, experimenter two measured all participants' BAC. Their BAC was continuously tested every 10 minutes until their BAC measured.002 or lower, indicating a negligible amount of alcohol. Participants' behavior was also monitored for abnormalities that may occur after consuming alcohol, but none were observed.

However, one participant insisted on leaving the laboratory early after completing the MCP and thus an Informed Emergency Form was signed, the Emergency Protocol was completed, and the IRB was informed of the incident. Figure 1 outlines the procedures completed during the laboratory sessions.

Statistical Analyses

First, to assess order effects, Independent Sample t-tests were run to determine if the crossover point during the alcohol condition was significantly different across participants who completed the alcohol condition first and those who completed the placebo condition during their initial laboratory session. Secondly, Paired Sample t-tests were completed to assess for a priming effect, by testing whether there were significant differences in the MCP crossover point and DAQ between the alcohol and placebo condition. Additional Paired Sample t-tests were run to determine if reported affect on the PANAS and subjective effects of alcohol on the BAES varied across lab conditions. Not all participants exhibited a priming effect. Therefore, one-way ANOVAs were run to assess if differences in drinking patterns, alcohol-related problems, drinking motives, and affect and subjective effects of alcohol after consuming the preloads were present across participants who exhibited a priming effect on the MCP and those that did not. Fourthly, regression analyses were conducted to assess whether DAQ accounted for a significant amount of variance in MCP crossover points. Additionally, a series of Pearson correlations were computed to measure the relationship between MCP crossover points past-month alcohol consumption, related problems, drinking motives, affect and subjective effects of alcohol. Lastly, regression analyses were run to determine the role of reported drinking patterns, alcohol-related problems, drinking motives, affect, and

subjective effects of alcohol on the variability in the priming effect, as quantified by the difference in MCP crossover points across the two laboratory conditions.

RESULTS

Order Effect

A significant main effect for order of laboratory condition on the difference in crossover point for the alcohol condition [t(19)=-.58, p=.57] was not observed between participants who completed the alcohol condition (M=9.27, SD=6.03) during the first session and those who consumed the alcohol preload during the second session (M=8.00, SD=3.56). The lack of main effect of order of condition suggests that no order effects was observed and that results can be analyzed cumulatively across all participants, without controlling for order of preload condition.

A mixed-design ANOVA was also run to test whether the interaction between order of preload administration, as a between-subject factor, and crossover points for the alcohol and placebo conditions, as a within-subject factor, was significant. The findings from this test suggest that the crossover points for the alcohol and placebo conditions did not significantly vary as a function of the order of preload administration ($F(1, 18) = .82$, $p=.38$).

Differences in Laboratory Variables Across the Two Preload Conditions

Table 1 contains the means for the variables collected across the two lab conditions. A difference score was computed to assess the difference in MCP crossover points between laboratory conditions for each participant. A t-test suggests that the difference between the crossover points for the alcohol and placebo condition is greater than zero [t(19)=1.93, p=.03]. However, the difference in DAQ between sessions was not greater than zero [t(19)=-.15, p=.44]. Additionally, no differences were observed between positive [t(19)=-.56, p=.58] and negative [t(19)=-.35, p=.73] affect, as reported on the

PANAS nor in stimulating [t(19)=1.10, p=.28] subjective effects of alcohol. However, participants reported significantly greater sedative effects of alcohol during the alcohol condition compared to the placebo condition [t(19)=2.6, p=.02]. Interestingly only sedating effects of alcohol and craving were significantly correlated with the MCP crossover point for the alcohol condition, as well as the change in MCP across preload condition.

Observed Priming Effect

Across the 20 participants who completed both laboratory sessions nearly half exhibited evidence of a priming effect (N=7), as measured by a greater MCP crossover point in the alcohol condition compared to the placebo condition. However, no crossover difference was observed among half of the laboratory participants (N=10), as the crossover points were the exact same during the alcohol and placebo condition. Additionally, a minority of participants (N=3) reported a negative crossover difference, in which the MCP crossover point was greater in the placebo condition than the alcohol condition. As the priming effect was not observed across the entire sample, it appears that there may be unique differences between those who exhibited sensitivity to the priming effect and those that evidenced no priming effect.

Differences in Survey and Laboratory Variables as a Function of Observed Priming Effect

Interestingly no differences were observed in drinking variables across the participants who exhibited a priming effect (N=7) and those that did not (N=13). A one-way ANOVA suggests that no differences were observed in number of drinks consumed in average week (F(2, 16) = .31, p=.74), number of binge episodes in prior 28 days (F(2,

16) = .25, p=.78), or number of alcohol-related problems in past month (F(2, 17) = .61, p=.55). Regarding drinking motives, no differences were observed in social (F(2, 16) = 1.62, p=.23), coping (F(2, 17) = 2.04, p=.16), enhancement (F(2, 17) = 2.04, p=.16) and conformity motives (F(2, 17) = 1.41, p=.27).

Additionally, no differences were observed in variables collected in the post-preload packet. One-way ANOVA's suggest that no differences were observed in the differences in positive affect (F(2, 17) = .50, p=.61), negative affect (F(2, 17) = .13, p=.89), sedating effects (F(2, 16) = .08, p=.93), and stimulating effects (F(2, 17) = .15, p=.87) between crossover groups who exhibited a priming effect and those who did not.

Desire to Drink Accounting for Variance in Crossover Point

Multiple regression analyses, with the MCP crossover point as the dependent variable, were conducted to determine the relative contribution of the desire to consume alcohol, as a predictor of variance in the subjective reinforcing value of alcohol. An initial analysis revealed that desire for alcohol, as measured by the DAQ, after the alcohol priming condition accounted for a significant amount of variance in the MCP crossover point in the alcohol condition [R2 = .24, F(1, 19)= 6.02, p=.02]. However, the DAQ did not significantly predict the MCP crossover point in the placebo condition [R2 = .12, F(1, 18)= 2.40, p=.14].

Correlates of Crossover Points

Pearson correlations were run to measure the strength of the relationship between survey and laboratory variables with MCP crossover points. Table 2 contains the correlations between survey variables collected and the responses collected in the laboratory alcohol condition. Interestingly, none of the variables collected in the

screening survey, nor in the post-preload packet, were significantly correlated with the MCP crossover point, aside from reported desire for alcohol on the DAQ. However, number of binge episodes in the past month and coping motives were significantly correlated with desire for alcohol. Table 3 contains the Pearson correlations for the survey variables and the laboratory variables collected after the placebo preload. None of the variables collected in the screening survey, nor in the placebo lab condition, were significantly correlated with the MCP crossover point and only number of past month binge episodes was significantly correlated with desire for alcohol. Regarding the differences observed between the two preload conditions, no variables were significantly correlated with the difference in MCP crossover point or the difference in reported desire for alcohol. Table 4 contains the Pearson correlations for the difference scores between sessions.

Accounting for variance in Priming Effect

A series of regression analyses, with the difference in MCP crossover points between priming conditions as the dependent variable, were conducted to determine the relative contribution of possible predictor variables accounting for variance in the change in reinforcing value between the two preload conditions. Each of the possible independent variables were included in the model one at a time, due to the limited sample size and the related concern that complex analyses would be underpowered. The independent variables included drinking motives, average number of drinks consumed in a week, binge episodes, alcohol-related problems, BAC after the alcohol preload, and reported desire for alcohol, affect, and subjective effects of alcohol for both conditions, as well as the difference in reporting between the two preload conditions. Additionally, due

to the number of participants who did not exhibit a priming effect, the distribution of difference score in MCP crossover points was not normal. The first series of analyses were completed without modifying outliers or transforming the difference scores, as the distribution, although skewed, appeared to possibly be the true distribution of the variance in the priming effect. After completing the first series of regression analyses, the only relationship that approached statistical significance was the difference in the sedating effects of alcohol between the two conditions [$R2 = .19$, $F(1, 18)= 4.27$, $p=.05$]. This result suggests that endorsement of greater sedating effects during the alcohol condition, relative to the placebo condition, was related to greater priming effect. All of the results from the first series of analyses are reported in Table 5.

Although the distribution and values of the difference scores appeared to be representative of the true population, the wide distribution of scores may have underpowered the first series of regression analyses. Thus, the second series of regression analyses were completed after recoding for univariate outliers. Three univariate outliers were identified. Univariate outliers were defined as scores that were greater than the median plus or minus two interquartile ranges. After the three outliers were recoded to the value of the median plus two interquartile ranges, the same series of regression analyses were completed. These series of analyses, with the difference in MCP crossover points with recoded outliers as the dependent variable, were all statistically insignificant (Table 6).

The third and final series of regression analyses were computed after transforming the difference scores by log10, due to the severe positive skewness of the crossover difference distribution and concern regarding the lack of normality impacting the

robustness of the regression analyses. After the difference scores were transformed the same series of regression analyses were completed with each of the unique independent variables (Table 7). One model was found to be significant, with the difference in the desire for alcohol between conditions accounting for 21% of the variance in the MCP crossover point difference score [$F(1, 18)= 4.74$, $p<.04$]. This finding suggests that greater endorsement of desire for alcohol in the alcohol, compared to the placebo, condition was related to a greater priming effect, as defined by a greater difference in the MCP crossover points between conditions.

DISCUSSION

The present study aimed to assess whether a validated behavior economics procedure is sensitive to the alcohol priming effect among at-risk binge drinking college males, as well as to clarify the relationship between the priming effect and drinking motives, affect after drinking, and subjective alcohol effects in a controlled laboratory setting. To date a behavioral economic task not been used to quantify preference for alcohol in a priming effect paradigm, nor has a study attempted to account for the priming effect in terms of drinking motives. Results of this study indicated that the MCP is a valid and sensitive measure of the priming effect and may be more sensitive than a self-report measure of desire for alcohol. However, the variables in this study, including drinking motives, were unable to consistently predict the priming effect, as measured by the difference in MCP crossover points between the alcohol and placebo condition. Though, there is some evidence that the sedating effects of alcohol and craving may account for significant amount of variance in the priming effect.

Order and Placebo Effects

The order of lab condition was counterbalanced, so that half of the participants completed the alcohol condition during their first lab session and half completed the alcohol condition during their second lab session. Regarding the magnitude of the difference in crossover points between the two lab conditions, a significant difference was not observed between participants who completed the alcohol condition during the first lab session compared to those who completed the alcohol condition during the second laboratory session. This finding suggests that an order effect was not observed;

thus, the intensity of the priming effect was not dependent on whether the alcohol condition was completed during the first or second laboratory sessions.

Additionally, among the minority of participants who reported their belief regarding whether he received alcohol during each lab session, participants were not able to detect better than chance whether he consumed alcohol or not during the placebo lab session. This finding suggests that the lab procedures sufficiently presented the placebo preload in a manner that could not reliably be identified as different than the alcohol condition. Further, non-alcoholic beer and growlers seem to be valid placebo products to use with binge drinking college males

Priming Effect

The current study predicted that the crossover point on the MCP would be greater after participants consumed alcohol, than when a placebo was consumed, suggesting a priming effect. Overall a significant difference was observed in crossover points between the preload conditions. Results suggest that after consuming an alcohol preload, participants valued alcohol more greatly, as evidenced by reporting greater preference for beer than escalating amounts of money on the MCP. This is similar to preexisting literature, which has displayed that after consuming an initial dose of alcohol social drinkers are likely to value alcohol more (e.g. de Wit & Chutuape, 1993; Rose & Grunsell, 2008).

Interestingly, craving for alcohol, as measured by the DAQ, did not significantly differ across lab conditions. The DAQ is a self-report measure that contains face valid items that access for current desire to consume alcohol (e.g. My desire to drink now seems overwhelming). However, some items on the DAQ assess for expectancies related

to alcohol ameliorating negative feelings (e.g. “Drinking now would make me feel less tense”), which appears similar, albeit unique, to coping drinking motives. As a relationship between coping motives and the priming effect was not found to be statistically significant, it may be that the inclusion of items related to coping motives in the DAQ undervalued the relationship between craving and the priming effect. Thus, a different measure of craving such as the Alcohol Urge Questionnaire (Bohn, Krahn, & Staehler, 1995), which does not include specific expectancies regarding by which mechanism drinking will result in a desired outcome (e.g. Have a drink now would make things seem just perfect), may have been significantly related to the priming effect.

Additionally, the lack of a significant difference observed in craving across conditions may also be due to the limited insight or awareness of changes in the subjective reinforcing value of alcohol by participants. Although the MCP compares alcohol to a common and daily encountered reinforcer (i.e. money) it does not instruct participants to verbally report or describe how much they value alcohol at the present time. This may control for the degree to which participants’ responses on the MCP is skewed by alcohol related beliefs. It may be that some participants are less willing to report, or are less aware of, their desire for alcohol due to previously developed beliefs related to the acceptability of craving alcohol and controlling one’s intake (e.g. I could easily limit how much I drank if I drank now). Therefore, self-reported measures are limited by the extent to which participants have the insight, and willingness, to accurately complete questionnaires. Thus, behavioral tasks such as the MCP may have greater sensitivity to changes in the reinforcing value of alcohol and may be capable of measuring changes in drinking behavior before changes in cognitions occur.

Affect

It was hypothesized that positive affect would be related to the priming effect, as that relationship has been observed in previous priming studies (e.g. Kirk & de Wit, 2000). However, in the current study no differences were observed in positive or negative affect across conditions and affect was not found to be a significant predictor of the priming effect. This may partially be due to affect only being measured once during each session, after the preload was consumed. If affect had been measured before and after the preload, difference in affect due to the preload could have been measured. Additionally, affect could more validly be tested in a controlled setting by completing a mood manipulation procedure. For example, a non-priming study found evidence that negative mood increases the reinforcing value of alcohol, as measured by the MCP, among participants who endorse coping drinking motives (Rousseau et al., 2011). Therefore, it could be that due to the lack of control and standardization of affect across the conditions in this study, affect was not found to be a significant predictor of the priming effect.

Subjective Effect of alcohol

Similar to positive affect, endorsement of stimulating effects of alcohol has been associated with a priming effect in previous priming studies (e.g. King et al., 2002) but in the current study no difference in stimulating effects was observed across the two preload conditions and stimulating effects of alcohol were not found to be related to the priming effect. However, greater sedative effects were reported in the alcohol condition than in the placebo condition. Additionally, discrepant from what was observed in other priming studies, a greater increase in sedating effects in the alcohol condition was related to the raw difference in crossover points between conditions. Although dissimilar from what

has been measured in other lab studies, perhaps this significant difference in sedating effect is due to the sterile laboratory environment in which the study was completed. It may be that the current lab environment was lacking, albeit purposefully, the environmental and social cues that are typically paired with intoxication.

Research has supported that many of the perceived positive effects of alcohol are due to placebo effects, consisting of expectations and the drinking environment (Marlatt & Rohsenow, 1981). Further, the true positive, including stimulating, effects of alcohol are only temporary unless maintained by other factors (e.g. social reinforcement, alcohol expectancies), while the sedating effects occur for a greater period of time (Larimer, Palmer & Marlatt, 1999). It may be that due to the participants' uncertainty about the preload condition, as well as consuming the preload in a sterile environment, participants were more aware of the "true" bodily effects of alcohol. This may have been due to participants having not been primed by alcohol expectancies or by social reinforcement. It also may have been that the "true positive effects" abated before the post-preload measures were completed. However, even though participants may have not been cognitively primed to experience the positive effects of alcohol, some of the participants appeared to value alcohol more greatly after consuming alcohol, suggesting that the elevated BAC resulted in a "true" priming effect, beyond a change in reinforcing value of alcohol due to placebo effects.

Secondly, the scale that was used in this study to measure sedative and stimulating effect of alcohol (BAES) defined the sedative effects in a manner that appears to imply a negative connotation. However, it may be that for some drinkers the sedating effects of alcohol are in fact desired. Although, "difficulty concentrating," having "slow

thoughts," and feeling "sluggish" appear to be undesirable, perhaps in a solitary setting or for certain individuals these experiences are in fact desired. This may partially be due to the discrepancy in how researchers, compared to drinkers, define alcohol-related factors. For example, considering alcohol-related problems, there is evidence to suggest that alcohol-related consequences that researchers define as problems or as negative outcomes may be assessed as neutral or even positively (e.g. having a hangover; unanticipated sexual encounter while intoxicated) by college drinkers (Mallett, Bachrach, & Turrisi, 2008). It may also be that stimulating effects are more desirable when drinking in a social setting; however, when drinking alone, as in the current study, feeling "talkative" or more stimulated may be a less desired outcome.

Variability in Priming Effect and Crossover Points

Evidence of a priming effect was not observed among all participants. In this study, over half of the participants did not exhibit an increase in the perceived value of alcohol after having consumed a dose of alcohol. The lack of a priming effect among a significant proportion of the sample may have been due to a peak BAC well below intoxication. It may be that if participants' BAC were elevated above .025, a larger percentage of the sample would exhibit signs of a priming effect. One might also hypothesize that there is something unique about individuals who exhibit a priming effect and thus certain drinkers may be at risk of drinking heavily due to this increase in the perceived value of alcohol after experiencing the initial effects of alcohol.

It would be clinically relevant to determine what differentiates drinkers who are more sensitive to the priming effect than those who are not. This is clinically relevant for prevention and intervention efforts, as college drinkers who are risk of valuing alcohol

more greatly after consuming an initial drink may be an especially high-risk population. College student have been identified as an at-risk population, as students appear to drink more heavily compared to their peers who are not enrolled in college (Slutske, 2005) and that alcohol significantly contributes to mortality in this population (Hingson, Zha, & Weitzman, 2009). Future research should assess whether college drinkers who are sensitive to the priming effect experience a compound effect of risk-factors related to harmful drinking.

In the current study no difference was observed in weekly drinking, binge episodes, or alcohol related problems between students who exhibited a priming effect and those who did not. However, these students may still be at increased risk for pathological use. For example, although many college students drinking heavily, it appears that the majority "phase out" of risky patterns of drinking as they progress towards gradation, so that by the end of their college education the majority of students no longer engage in high-risk drinking behaviors (Jackson, Sher, Gotham, & Wood, 2001). Therefore, although in this sample sensitivity to the priming effect did not seem to be related to engaging in riskier use than binge drinking males who did not exhibit a priming effect, it may be that those sensitive to the priming effect may continue to engage in heaving drinking after completing college due to their sensitivity to the priming effect.

Additionally, although craving did not significantly vary across conditions or account for variability in priming effect, craving for alcohol during the alcohol condition did significantly predict the crossover point in the alcohol condition. Interestingly, craving in the placebo condition did not predict the crossover point after the placebo preload. It may be that crossover point in the placebo condition was influenced by factors

not manipulated or controlled for in the study (e.g. academic pressures, social responsibilities) or due to stable factors (e.g. beliefs related to alcohol). Previous MCP studies have looked at the reinforcing value of alcohol in participants who are sober and variability in the crossover point has been observed. Therefore it maybe that during the placebo condition, the MCP was sensitive to external factors not measured in this study, such as the presence of drug-free reinforcers in the participants' life (Correia, Simons, Carey, & Borsari, 1998).

Additionally, different than previous studies, reported past-month drinking patterns were not significantly correlated with the crossover points for each preload condition or the difference in scores between conditions. Little and Correia (2006) found that among a coed sample of college drinkers, crossover points on a hypothetical and laboratory version of the MCP were positively correlated with drinking variables. Results of that study suggest that increases in alcohol use may be due to the increased relative reinforcing value of alcohol; though, that relationship was not supported by the current findings. This may in part be due to the differences in the samples used for the two studies, as in the present study only binge-drinking males were included.

Among the present sample social motives were the most highly endorsed drinking motive and previous research has suggested that college males drink for social motives significantly more than their female peers (e.g. Simons, Correia, & Carey, 2000; Gire, 2002). It might be that some binge-drinking males, including the current sample, are less influenced by a stable subjective value of alcohol, as their decision to drink might be more greatly influenced by social pressures. That is, some college males may exhibit high levels of alcohol consumption in the absence of a fixed increase in the relative reinforcing

value of alcohol. As the MCP in both studies was completed individually, it may not have captured the possible fluctuations in the subjective value of alcohol that might be accounted for by specific environments related to binge drinking (e.g. fraternity parties, tailgating). Little and Correia may have observed a significant relationship between past drinking and crossover points, due to the large representation of women in their study (75% women in the hypothetical MCP version and 50% in the laboratory version) who reportedly do not endorse drinking for social reasons as greatly as men. Thus, it seems clinically relevant to consider which drinkers may exhibit elevated reinforcement from alcohol that is fixed, or is related to the priming effect, and how the college environment can be modified to attenuate the social factors that may result in increased reinforcement from alcohol.

Clinical Implications

As some individuals appear to have greater sensitivity to the priming effect than others, if it is possible, it may be valuable to identify those students with greater sensitivity and to provide them with blood alcohol concentration (BAC) estimating training. In a review by Aston and Liguori (2013), the literature is promising in terms of BAC estimating training with social drinkers. However, across numerous studies the training has been shown to be unsuccessful for adults with a substance use disorder, as many of the those participants were not able to accurately estimate their BAC and the training did not result in a decrease in their alcohol consumption, which was the objective of those trainings. This suggests that although BAC estimating training may be most beneficial for social drinkers who have not yet progressed to pathological levels of drinking. Thus, it should be tested whether this training would be effective for students

who binge drink and have heightened sensitivity to the priming effect. Further, as a prevention effort, it may be valuable to test whether students who are sensitive to the priming effect, but have yet to establish heavy or hazardous binge drinking, can be trained to estimate their BAC and use that awareness to moderate their drinking.

Related to the MCP, the crossover point has been shown in other studies to be significantly related to frequency and quantity of drinking and alcohol-related problems (Little & Correia, 2006) and in the current study it was sensitive to the priming effect. Thus, it may be relevant for college students to complete a hypothetical MCP, or another measure assessing the subjective value of alcohol, before receiving alcohol-related services to inform his/her clinician about the relevant risks and treatment targets that should be discussed. Identifying which students highly value alcohol and are considerably sensitive to the priming effect may help clinicians screen for which students may benefit the greatest from intervention efforts. Additionally, colleges could make efforts to increase the behavioral price of alcohol, as well as decrease the price of substance-free activities that may be attractive to this at-risk population. In doing so, prevention efforts may be able to decrease the subjective value of drinking by cultivating an environment where non-drinking reinforcement is more salient and readily available (Murphy, Correia, & Barnett, 2007).

Related, interventions may benefit from assessing the availability, interest, and perceived value of substance-free activities that have both immediate and delayed reinforcement. In doing so, interventions may be improved by promoting engagement in activities incompatible with drinking and in fostering the significance of delayed reinforcement activities (e.g. academic and health outcomes) (Murphy et al., 2007). This

type of intervention is supported by behavioral economic theory, which proposes that the availability and value of alternative reinforcers influence the subjective value of alcohol (Vuchinich & Tucker, 1988), and has been supported by research assessing the impact of a supplemental session that emphasizes substance-free activities, in conjunction with a traditional brief motivational intervention, on alcohol-related variables at follow-up.

In one study a sample of binge drinking (1 or more binge episodes in month prior to completing screening survey) college freshman participated in a brief motivational intervention that included a session tailored to increase the salience of substance free and delayed rewards (i.e. academic & career), by discussing goal setting, the behaviors necessary to obtain those goals (e.g. studying), and how drinking may impact those attempts (Murphy, Skidmore, Dennhardt, Martens, Borsari, Barnett, & Colby, 2012). At a one-month follow-up, the majority of participants reduced the number of binge episodes they engaged in, reduced their estimated peak BAC, and reduced the number of drinks they consumed in a week. A follow-up randomized controlled trial found that students who completed a brief motivational intervention plus a substance-free activity session, endorsed fewer alcohol-related problems at 1 and 6-month follow-up compared to peers who completed a brief motivation intervention plus relaxation session (Murphy, Dennhardt, Skidmore, Borsari, Barnett, Colby, & Martens, 2012). Further, among participants who endorsed symptoms of depression and low levels of engagement in and enjoyment from substance-free reinforcement at baseline, reported greater reductions in heavy drinking in the substance-free session treatment condition. Results from these two studies suggest that assessing reinforcement from substance use and substance-free activities and targeting those variables in session may improve college interventions.

Limitations

A major limitation of the present study was that data collection was constrained to a laboratory setting. It has been widely observed that the environment in which one consumes alcohol can significantly impact the individual's craving for that substance. This is partly due to stimuli associated with intoxication eliciting increased motivation to consume alcohol, due to cue-reactivity that is strengthened over repeated exposures (e.g. Pomerleau, Fertig, Baker, & Cooney,1983; Greeley, Swift, Prescott, & Heather, 1993). The generalizability, or degree of difference that would be observed in a real-life setting in which the individual typically consumes alcohol, is unknown. Thus, the laboratory environment has limitations regarding external validity in terms of the extent in which the findings may generalize to alternative environments and participants. However, the control the laboratory provides the experimenter with manipulating variables results in greater internal validity and thus greater confidence in ruling out alternative explanations to elucidate the results. Future studies should consider the extent to which the laboratory setting differs from the participant's typical drinking environment, as well as the impact of drinking alone versus with peers and in a laboratory environment that more closely resembles the participants drinking environment, for example a laboratory designed to mimic a bar or dormitory.

Additionally, all laboratory sessions occurred at four in the afternoon, Monday through Thursday. Although each participant was asked not to bring schoolwork with him, the time and date of the sessions may have impacted the participant's motivation to consume alcohol. In a hypothetical purchasing task, college students reported that they would consume less alcohol if he/she had class or a test scheduled for the next day than if

he/she had no responsibilities (Skidmore & Murphy, 2011). This study suggests that next day responsibilities may impact alcohol demand and perhaps the reinforcing value of alcohol. Future studies should consider assessing for responsibilities the participants have for the evening after the laboratory session, as well as for the following day.

Regarding the homogeneity of the current sample, all participants were college males who endorsed at least one binge episode during the 28 days before completing the screening survey. Although college males was the sample of interest for this study, it would be valuable to asses whether these results generalize to all college drinking men and women. Specifically, it would be valuable to determine whether similar relationships between drinking motives and priming are present among male drinkers who do not binge drink. In particular, it is unknown whether the same risk factors for sensitivity to the priming effect is present among moderate drinkers. If the same risk factors were found among moderate drinkers, than those factors should be targeted in secondary prevention efforts to promote low-risky drinking habits among college students. Regarding risk factors for women, drinking differences have consistently been observed between men and women drinkers (e.g. Grant et al. 2004; White et al. 2006). However, there is recent evidence that among young adults and adolescents, women may experience some of the same social pressures to consume alcohol. For example, adolescent drinking patterns are becoming comparable across men and women (e.g. Johnston, O'Malley, Bachman, & Schulenberg, 2006) and college women may be more likely to exceed the NIAAA suggested weekly drinking limits, albeit the weekly limit is lower for women (7 or fewer drinks) than men (no more than 14) (Hoeppner, Paskausky, Jackson, & Barnett, 2013). Therefore, considerable attention should be given to

assessing what gender differences are present in the priming effect and if prevention and intervention efforts should be customized based on the student's gender. Further, considering non-college student drinkers, studying the relationship between drinking motives and the reinforcing value of drinking should be investigated in adolescents, in regards to primary prevention efforts, as well as older adults with and without an alcohol use disorder. Expanding the current literature on the priming effect of alcohol, would be especially relevant in better understanding the developmental process related to developing hazardous and moderate alcohol use patterns.

Another limitation was the relatively small sample size of 20. However, previous MCP and priming studies have demonstrated effects with similar or smaller sample sizes or with a between subject design. A previous MCP study with alcohol displayed delay effects with 21 participants (Little & Correia, 2006) and a between subject design found effects of a mood manipulation and drinking motives on the reinforcing value of alcohol with 44 participants (Rousseau et al., 2011). Moreover, the MCP has detected dose effects among 20 participants for nicotine (Griffiths et al., 1993) and with 12 participants for pentobarbital (Griffiths et al., 1993). Additionally, priming studies have detected significant effects with comparable sample sizes. Past studies with a repeated-measure design have detected a priming effect among 12 (de Whit & Chutuape, 1993; Kirk et al., 2000) and 11 (Chutuape et al., 1994) social drinkers. Further, priming studies that detected effects between participants have had similar samples sizes including 20 females with alcohol dependence (Hodgson et al., 1979), 20 (combined) binge and non-binge drinkers (Rose & Grunsell, 2008), and 24 veteran males (Ludwig et al., 1974).

Therefore, the number of participants in the present study should have provided sufficient power to detect significant differences in the priming effect and response variation on the MCP. Considering the lack of statistically significant relationship observed in this study, there may be true effects present between the priming effect and drinking motives, affect after consuming alcohol, and subjective effects of alcohol that were not detected due to limited power. However, it may also be that the results of this study are a valid representation of the priming effect among high-risk drinking college males. A larger sample size, with greater power, would have allowed for the application of more sophisticated data analyses including modeling to detect simultaneously how multiple exogenous variables predict variance in the priming effect, as well as the possibility to employ a measurement model to create a latent variable of the priming effect. Additionally, the modest sample size limited the ability to run regression analyses with multiple independent variables. Although this study was partially exploratory, the probability of Type one error due to the number of analyses ran is a limitation and the current sample size limited the ability to run more complex models as those analyses would have been significantly underpowered.

Lastly, the lack of a robust priming effect and of more significant predictors, may have been limited by the moderate peak BAC. As a BAC of .025 is well below the legal definition of intoxication (.08), it may be that the effects of alcohol at a moderate BAC are not great enough to be related to a priming effect. Additionally, the modest peak BAC may have been related to the lack of emotional differences and stimulating effects of alcohol between preload conditions. The lack of variability in affect and stimulating effects between conditions may have also limited our ability to observe and predict the

priming effect. Related, the low internal consistency of the PANAS negative affect subscale may have also restricted the difference observed across sessions, as well as the possibility of negative affect accounting for variance in the priming effect.

Future Directions

Future research can expand upon the current study by completing the same laboratory procedures with a greater sample size and peak BAC. A larger sample would allow for the use of more sophisticated analyses, as well as to rule out the possibility that some of the null findings in the current study were due to limited power. A greater peak BAC may allow for larger variability in emotional states and subjective effects of alcohol to be observed, which may influence the robustness of the priming effect. Additionally, although males appear to be at greater risk of harmful alcohol use, it would be valuable to expand this area of research to college women and to non-binge drinkers.

Regarding the potential risk of sensitivity to the priming effect, a longitudinal study that tested whether college males who are sensitive to the priming effect continue to drink heavily after completing their college education, would be useful in understanding the related risk. It would be valuable to track students over time, to decipher whether in the absence of a college environment participants who are sensitive to the priming effect continue to drink heavily, unlike their peers who without intervention engage in more moderate drinking by the end of their college education. This kind of study could identify the long-term risks associated with the priming effect in establishing hazardous drinking patterns.

REFERENCES

Aston, E. R. & Liguori, A. (2013). Self-estimation of blood alcohol concentration: A review. *Addictive Behaviors, 38(4)*, 1944-1951.

Baker, A.G., Steinwald, H., & Bouton, M.E. (1991). Contextual conditioning and reinstatement of extinguished instrumental responding. *The Quarterly Journal of Experimental Psychology, 43B*, 199-218.

Benson, T.A., Little, C.S., Henslee, A. M., & Correia, C.J. (2009). Effects of reinforcer magnitude and alternative reinforcer delay on preference for alcohol during a multiple-choice procedure. *Drug and Alcohol Dependence*, *100*, 161-163.

Bickel, W. K., & Kelly, T. H. (1988). The relationship of stimulus control to the treatment of substance abuse. In B. A.Ray (Ed.), *Learning factors in substance abuse* (NIDA Research Monograph 84, 122-140).

Bickel, W. K., Marsch, L. A., & Carroll, M. E. (2000). Deconstructing relative reinforcing efficacy and situating the measures of pharmacological reinforcement with behavioral economics: A theoretical proposal. *Psychopharmacology*, *153*, 44 –56.

Bigelow, G. E., Griffiths, R. R., & Liebson, I. A. (1977). Pharmacological influences upon ethanol self-administration. In M. M.Gross (Ed.), *Alcohol intoxication and withdrawal* (Vol. IIIB, 523-538). New York: Plenum Press.

Bohn, M.J. Krahn, D.D., & Staehler, B.A. (1995). Development and initial validation of a measure of drinking urges in abstinent alcoholics. Alcoholism: Clinical and Experimental Research 19(3), 600–606.

Bouton, M. E., & Swartzentruber, D. (1991). Sources of relapse after extinction in Pavlovian and instrumental learning. *Clinical Psychology Review*, *11*, 123-140.

Carpenter, K. M. & Hasin, D. S. (1998). Reasons for drinking alcohol: Relationships with DSM-IV alcohol diagnoses and alcohol consumption in a community sample. *Psychology of Addictive Behaviors*, *12(3),* 168-184.

Carroll, M. E. & Comer, S. D. (1996). Animal models of relapse. Experimental *Clinical Psychopharmacology. 4*, 11-18.

Chutuape, M. A., Mitchell, S. H., & de Wit, H. (1994). Ethanol preloads increase ethanol preference under concurrent random-ratio schedules in social drinkers. *Experimental and Clinical Psychopharmacology*, *2*, 310-318.

Clark, D. (1994). Craving for alcohol. *Journal of Psychopharmacology, 9*, 73-76.

Collins, R., Parks G.A., & Marlatt, G. (1985). Social determinants of alcohol consumption: The effects of social interaction and model status on the self-administration of alcohol. *Journal of Consulting and Clinical Psychology*, *53*, 189–200.

Cooper, M. L. (1994). Motivation for alcohol use among adolescents: Development and validation of a four-factor model. *Psychological Assessment*, *6(2),* 117-128.

Correia, C. J., Simons, J., Carey, K. B., & Borsari, B. E. (1998). Predicting drug use: Application of behavioral theories of choice. *Addictive Behaviors, 23(5)*, 705-710.

Cox, W. M. & Klinger E. (1988). A Motivational Model of Alcohol Use. *Journal of Abnormal Psychology*, *97(2),* 168-180.

Cox, W. M. & Klinger, E. (1990). Incentive motivation, affective change, and alcohol use: A model. In W. M. Cox (Ed.), *Why people drink: Parameters of alcohol as a reinforcer* (pp. 291-314). New York: Amereon Press.

de Wit, H, & Chutuape, MA (1993) Increased ethanol choice in social drinkers following ethanol preload. *Behavioral Pharmacology, 4*, 29–36.

de Wit, H. (1996). Priming effects with drugs and other reinforcers. *Experimental and Clinical Psychopharmacology, 4(1) Special Section: Relapse to Substance Abuse: Recent Findings From Basic and Clinical Research,* 5-10.

Engle, K. B. & Williams, T. K. (1972). Effect of an ounce of vodka on alcoholics' desire for alcohol. *Quarterly Journal of Studies on Alcohol*, *33(4-A),* 1099-1105.

Garett, B. E. & Griffiths, R. R. (1998). Physical dependence increases the relative reinforcing effects of caffeine versus placebo. *Psychopharmacology*, *139(3),* 195-202.

Gerber, G. J. & Stretch, R. (1973). Drug-induced reinstatement of amphetamine self-administration behavior in monkeys. *Canadian Journal of Psychology, 27*, 168-177.

Gire, J. T. (2002). A cross-national study of motives for drinking alcohol. *Substance Use and Misuse, 37(2),* 215 – 223.

Greeley, J. D., Swift, W., Prescott, J. & Heather, N. (1993) Reactivity to alcohol-related cues in heavy and light drinkers. *Journal of Studies on Alcohol, 54*, 359–368

Greenwald, M. K. & Stitzer, M. L. (2000). Antinociceptive, subjective and behavioral effects of smoke marijuana in humans. *Drug and Alcohol Dependence*, *59(3)*, 261-275.

Grant, B. F., Dawson, D. A., Stinson, F. S., Chou, S. P., Dufour, M. C., & Pickering, R. P. (2004). The 12-month prevalence and trends in DSM–IV alcohol abuse and dependence: United States, 1991–1992 and 2001–2002. *Drug and Alcohol Dependence, 74*, 223–234.

Griffiths, R. R., Troisi, J. R., Silverman, K., & Mumford, G. K. (1993). Multiple-choice procedures: an efficient approach for investigating drug reinforcement in humans. *Behavioral Pharmacology, 4(1)*, 3-13.

Griffiths, R. R., Rush, C. R., & Puhala, K. A. (1996). Validation of the Multiple-Choice Procedure for Investigating Drug Reinforcement in Humans. *Experimental and Clinical Psychopharmacology*, *4(1),* 97-106.

Gruenewald, P. J., Johnson, F. W., Ponicki, W. R., LaScala, E. A. (2010). A dose response perspective on college drinking and related problems. *Addiction, 105(2)*, Feb, 257-269.

Herrnstein, R. J. (1970). On the law of effect. *Journal of the Experimental Analysis of Behavior*, *13(2),* 243-266.

Hingson, R., Heeren, T., Winter, M., & Wechsler, H. (2005). Magnitude of alcohol-related mortality and morbidity among U.S. college students ages 18–24: Changes from 1998 to 2001. *Annual Review of Public Health, 26*, 259–279

Hingson, R. W., Zha, W., & Weitzman, E. R. (2009). Magnitude of and the trends in alcohol-related mortality and morbidity among U.S. college students ages 18 –24, 1998 –2005. *Journal of Studies on Alcohol and Drugs, 16*, 12–20

Hodgson, R, Rankin, H, & Stockwell, T (1979). Alcohol dependence and the priming effect. *Behavior Research and Therapy, 17,* 379–387.

Hoeppner, B. B., Paskausky, A. L., Jackson, K. M., Barnett, N. P. (2013). Sex differences in college student adherence to NIAAA drinking guidelines. *Alcoholism: Clinical and Experimental Research, 37(10)*, 1779-86.

Hursh, S.R. (2000). Behavioral Economic Concepts and Methods for Studying Health Behavior. In W.K. Bickel & R. E. Vuchinich (Eds.), *Reframing Health Behavior Change with Behavioral Economics* (pp. 27-60). Mahwah, NJ: Lawrence Erlbaum Associates.

Jackson, K. M., Sher, K. J., Gotham, H. J., & Wood, P. K. (2001). Transitioning into and out of large-effect drinking in young adulthood. *Journal Of Abnormal Psychology, 110(3),* 378-391.

Johnston, L. D., O'Malley, P. M., Bachman, J. G., & Schulenberg, J. E. (2006). Demographic and subgroup trends for various licit and illicit drugs, 1975–2005 (

Monitoring the Future Occasional Paper No. 63) [On-line]. Ann Arbor, MI: Institute for Social Research. Retrieved from http://monitoringthefuture.org/

Jones, H. E., Garrett, B. E., & Griffiths R. R. (1999). Subjective and Physiological Effects of Intravenous Nicotine and Cocaine in Cigarette Smoking Cocaine Abusers. *The Journal of Pharmacology and Experimental Therapeutics*, *288*, 188-197.

Keane, T. M., Lisman, S. A., & Kreutzer, J. (1980). Alcoholic beverages and their placebos: An empirical evaluation of expectancies. *Addictive Behaviors*, *5(4),* 313-328.

King, A. C., Houle, T., de Wit, H., Holdstock, L., & Schuster, A. (2002). Biphasic alcohol response differs in heavy versus light drinkers. *Alcoholism: Clinical and Experimental Research, 26(6)*, 827-835.

Kirk, J. M. & de Wit, H. (2000). Individual differences in the priming effect of ethanol in social drinkers. *Journal of Studies on Alcohol, 61(1)*, 64-71.

Lanier, S. A., Hayes, J. E., & Duffy, V, B. (2005). Sweet and bitter tastes of alcoholic beverages mediate alcohol intake in of-age undergraduates. *Physiology & Behavior, 83(5)*, 821-831.

Larimer, M. E., Palmer, R. S., & Marlatt, G. (1999). Relapse prevention: An overview of Marlatt's cognitive-behavioral model. *Alcohol Research & Health, 23(2),* 151-160.

Lile, J. A., Stoops, W. W., Glaser, P. E. A., Hays, L. R., & Rush, C. R., (2004). Acute administration of the GABA reuptake inhibitor tiagabine does not alter the effects of oral cocaine in humans. *Drug and Alcohol Dependence, 76(1)*, 81-91.

Little, C. & Correia. C. (2006). Use of a multiple choice procedure with college student drinkers. *Psychology of Addictive Behaviors*, *20(4),* 445-452.

Love, A., James, D., & Willner, P. (1998). A comparison of two alcohol-craving questionnaires. *Addiction*, *93*, 1091-1102.

Ludwig, A. M., & Wikler, A. (1974). ‘Craving' and relapse to drink. *Quarterly Journal Studies of Alcohol*, *35,*108-130.

Mallett, K. A., Bachrach, R.L., & Turrisi, R. (2008). Are all negative consequences truly negative? Assessing variations among college students’ perceptions of alcohol related consequences. *Addictive Behaviors*, *33(10),* 1375-1381.

Marlatt, A. G., Demming, B., & Reid, J. B. (1973). Loss of control drinking in alcoholics: An experimental analogue. *Journal of Abnormal Psychology, 81(3)*, 233-241.

Marlatt, G. A. (1983). The controlled drinking controversy: A commentary. *American Psychologist, 38(10)*, 1097-1110.

Martin, C. S., Earleywine, M., Musty, R. E., Perrine, M. W., & Swift, R. M. (1993). Development and validation of the Biphasic Alcohol Effects Scale. *Alcoholism: Clinical and Experimental Research, 17*, 140-146.

Mello, N. K. & Mendelson, J. H. (1965). Operant Analysis of drinking Patterns of Chronic Alcoholics. *Nature*, *206*, 43-46.

Murphy, J. G., Correia, C. J., & Barnett, N. P. (2007). Behavioral economic approaches to reduce college student drinking. *Addictive Behaviors, 32(11),* 2573-85.

Murphy, J. G., Correia, C. J., & Vuchinich, R. E. (2009). The behavioral economics of substance abuse. In L. M. Cohen, F. R. Collins, A. M. Young, D. E. McChargue & T. R. Leffingwell (Eds.). *The pharmacology and treatment of substance abuse: An evidence based approach.* Mahwah, NJ: Erlbaum.

Murphy, J. G., Dennhardt, A.A., Skidmore, J.R., Borsari, B., Barnett, N. P., Colby, S. M., Martens, M. P. (2012). A randomized controlled trial of a behavioral economic supplement to brief motivational interventions for college drinking. *Journal of Consulting and Clinical Psychology, 80(5)*, 876-86.

Murphy, J. G., Skidmore, J. R., Dennhardt, A. A., Martens, M. P., Borsari, B., Barnett, N. P., Colby, S. M. (2012). A behavioral economic supplement to brief motivational interventions for college drinking. *Addiction Research & Theory, 20(6),* 456-465.

Pomerleau, O. F., Fertig, J. B., Baker, L., & Cooney, N. (1983). Reactivity to alcohol cues in alcoholics and non-alcoholics: Implications for a stimulus control analysis of drinking. *Addictive Behaviors, 8(1)*, 1-10.

Rohsenow, J. D. & Marlatt, A. G. (1981). The balanced placebo design: Methodological considerations. *Addictive Behaviors, 6(2)*, 107-122.

Rose, A. K. & Duka, T. (2006). Effects of dose and time on the ability of alcohol to prime social drinkers. *Behavioural Pharmacology, 17(1)*, 61-70.

Rose, A. K. & Grunsell, L. (2008). The subjective, rather than the disinhibiting, effects of alcohol are related to binge drinking. *Alcoholism: Clinical and Experimental Research, 32(6)*, 1096-1104.

Rousseau, G.S., Irons, J.G., & Correia, C.J. (2011). The reinforcing value of alcohol in a drinking to cope paradigm. *Drug and Alcohol Dependence*, 118, 1-4.

Seo, D. C. & Li, K. (2009). Effects of college climate on students' binge drinking: Hierarchical generalized linear model. *Annals of Behavioral Medicine, 38*, 262–268.

Simons, J., Correia, C. J., & Carey, K. B. (2000). A comparison of motives for marijuana and alcohol use among experienced users. *Addictive Behaviors, 25(1)*, 153 – 160.

Skidmore, J. R. & Murphy, J. G. (2011). The effect of drink price and next-day responsibilities on college student drinking: A behavioral economic analysis. *Psychology Of Addictive Behaviors, 25(1),* 57-68.

Slutske, W. S. (2005). Alcohol use disorders among U.S. college students and their non-college-attending peers. *Archives of General Psychiatry, 62*, 321–327.

Stewart, J., de Wit, H., & Eikelboom, R. (1984). Role of unconditioned and conditioned drug effects in the self-administration of opiates and stimulants. *Psychological Review, 91*, 251–268.

Substance Abuse and Mental Health Services Administration, *Results from the 2011 National Survey on Drug Use and Health: Mental Health Findings*, NSDUH Series H-45, HHS Publication No. (SMA) 12-4725. Rockville, MD: Substance Abuse and Mental Health Services Administration, 2012.

Tancer, M. & Johnson, C. (2007). The effects of fluoxetine on the subjective and physiological effects of 3,4-methylenedioxymethamphetamine (MDMA) in humans. *Psychopharmacology, 189(4)*, 565-573.

Vuchinich, R. E. & Tucker, J. A. (1988). Contributions From Behavioral Theories of Choice to an Analysis of Alcohol Abuse. *Journal of Abnormal Psychology*, *97(2),* 181-195.

Watson, D., Clark, L. A., & Tellegen, A. (1988b). Development and validation of brief measures of positive and negative affect: The PANAS Scales. *Journal of Personality and Social Psychology, 47*, 1063–1070

Wechsler, H., Davenport, A., Dowdall, G., Moeykens, B., & Castillo, S. (1994). Health and behavioral consequences of binge drinking in college: A national survey of students at 140 campuses. *Journal of the American Medical Association*, *272(21)*, 1672-1677.

Wechsler, H., Dowdall, G., Davenport, A., & Rimm, E.B. (1995). A Gender-Specific Measure of Binge Drinking Among College Students. *American Journal of Public Health*, *85(7),* 982-985.

White, H. & Labouvie, E., (1989) Towards an assessment of adolescent problem drinking, *Journal of Studies on Alcohol, 50*, 30–37.

White, H. R., McMorris, B. J., Catalano, R. F., Fleming, C. B., Haggerty, K. P., & Abbott, R. D. (2006). Increases in alcohol and marijuana use during the transition out of high school into emerging adulthood: The effects of leaving home, going to college, and high school protective factors. *Journal of Studies on Alcohol, 67*, 810–822.

APPENDIX OF TABLES

Table 1.
Descriptive Statistics Across Lab Conditions

	Alcohol Condition		Placebo Condition	
	Mean	SD	Mean	SD
MCP Crossover	8.67	4.93	7.10	4.59
Desire for Alcohol	48.90	9.88	48.55	9.921
Positive Affect	25.81	7.97	26.25	7.48
Negative Affect	12.10	2.02	12.40	3.00
Stimulating Effect Alcohol	15.52	14.92	12.85	13.27
Sedating Effect Alcohol	8.81	8.97	5.6	7.90

Table 2
Correlation Matrix: Survey and Lab Variables In the Alcohol Condition

Variable	1	2	3	4	5	6	7	8	9	10	11	12
Past-month Alcohol use												
1. Drinks per week												
2. Binge episodes	.67**											
3. Related problems	.31	.30										
Drinking Motives												
4. Social	.07	.02	-.18									
5. Coping	.13	.23	.25	.34								
6. Enhancement	.30	.11	-.09	.68**	.48*							
7. Conformity	-.30	-.08	.09	.50*	.28	.20						
Value in Alcohol Condition												
8. MCP crossover point	-.08	-.003	.05	-.12	.04	-.04	.06					
9. Desire for Alcohol	.22	.51*	.19	.01	.61**	.17	.26	.49*				
10. Negative Affect	-.02	.34	.29	.06	.53*	.05	.30	.15	.55*			
11. Positive Affect	.05	.18	.002	.28	.34	.20	.20	-.12	.29	.21		
12. Stimulating Effects	.11	.30	.21	-.12	.39	-.08	-.12	.29	.47*	.29	.39	
13. Sedating Effects	-.16	.05	.10	.05	.39	.17	.28	.45*	.58*	.43	.03	.48*

Note: * = p<.05, **=p<.01

Table 3
Correlation Matrix: Survey and Lab Variables In the Placebo Condition

Variable	1	2	3	4	5	6	7	8	9	10	11	12
Past-month Alcohol use												
1. Drinks per week												
2. Binge episodes	.67**											
3. Related problems	.31	.30										
Drinking Motives												
4. Social	.07	.02	-.18									
5. Coping	.13	.23	.25	.34								
6. Enhancement	.30	.11	-.09	.68**	.48*							
7. Conformity	-.30	-.08	.09	.50*	.28	.20						
Value in Placebo Condition												
8. MCP crossover point	.20	.26	.33	-.09	.10	-.06	-.14					
9. Desire for Alcohol	.26	.54*	.24	-.12	.33	.03	-.13	.34				
10. Negative Affect	-.08	.18	.18	-.27	.41	-.04	.10	.47*	.53*			
11. Positive Affect	.09	.11	.06	.23	.09	-.01	.33	.12	.21	.11		
12. Stimulating Effects	.29	.23	-.02	.14	.23	.15	-.05	.33	.33	.23	.73**	
13. Sedating Effects	.02	.35	.33	-.04	.60**	.06	.25	.46*	.39	.59	.19	.45*

Note: * = p<.05, **=p<.01

Table 4
Correlation Matrix: Survey Variables and Difference Scores in Lab Variables between Conditions

Variable	1	2	3	4	5	6	7	8	9	10	11	12
Past-month Alcohol use												
1. Drinks per week												
2. Binge episodes	.67**											
3. Related problems	.31	.30										
Drinking Motives												
4. Social	.07	.02	-.18									
5. Coping	.13	.23	.25	.34								
6. Enhancement	.30	.11	-.09	.68**	.48*							
7. Conformity	-.30	-.08	.09	.50*	.28	.20						
Difference between Conditions												
8. MCP crossover point	-.39	-.33	-.33	-.05	-.09	-.03	.28					
9. Desire for Alcohol	.03	.11	.02	.13	.44	.18	.44	.33				
10. Negative Affect	.08	.06	.03	.38	-.05	.08	.14	.06	-.06			
11. Positive Affect	.01	.15	-.08	.12	.46*	.40	-.22	-.21	.10	-.17		
12. Stimulating Effects	-.22	.09	.25	-.34	.19	-.29	-.04	.07	.14	-.22	.19	
13. Sedating Effects	-.33	-.44	-.30	.14	-.21	.15	.14	.44	.17	-.04	-.13	.17

Note: * = p<.05, **=p<.01

Table 5
Regression Analyses of the Difference in the Multiple Choice Procedures Crossover Points

Predictor	B	SEB	ß	T	R2
Drinking Motives					
Coping	-.11	.30	-.09	-.37	.01
Social	-.04	.20	-.05	-.20	<.01
Enhancement	-.02	.21	-.03	-.10	<.01
Conformity	.67	.55	.28	1.22	.08
DDQ					
Average weekly drinks	-.13	.07	-.39	-1.75	.15
No. Binge episodes	-.24	.16	-.33	-1.44	.11
RAPI	-.17	.11	-.33	-.149	.11
BAC post-Alcohol preload	23.40	95.38	.06	.25	<.01
PANAS					
Positive Affect- Alcohol Condition	-.14	.11	-.29	-1.27	.08
Negative Affect – Alcohol Condition	-.03	.45	-.02	-.07	v
Positive Affect – Placebo Condition	-.09	.12	-.18	-.76	.03
Negative Affect – Placebo Condition	-.08	.31	-.06	-.26	<.01
Difference in Positive Affect between Conditions	-.17	.19	-.21	-.91	.38
Difference in Negative Affect between Conditions	.10	.38	.06	.26	<.01
Desire for Alcohol					
Alcohol Condition	.04	.09	.09	.38	.01
Placebo Condition	-.11	.11	-.23	-1.00	.05
Difference between conditions	.15	.10	.33	1.46	.11
Biphasic Effects of Alcohol					
Stimulating Effect - Alcohol Condition	-.05	.06	-.18	-.79	.03
Sedating Effect – Alcohol Condition	.10	.10	.23	1.00	.05
Stimulating Effect – Placebo Condition	-.08	.07	-.28	-1.21	.08
Sedating Effect – Placebo Condition	-.03	.12	-.07	-.28	<.01
Difference in Stimulating Effects between Conditions	.02	.07	.07	.28	<.01
Difference in Sedating Effects between Conditions	.29	.14	.44	2.07	.29*

Note: * = p≤.05

Table 6
Regression Analyses of the Difference in the Multiple Choice Procedures Crossover Points with Recoded Outliers

Predictor	B	SEB	ß	T	R2
Drinking Motives					
Coping	-.06	.12	.12	.51	.01
Social	-.01	.08	-.02	-.08	<.01
Enhancement	-.10	.09	-.03	-.12	<.01
Conformity	.42	.21	.42	1.96	.18
DDQ					
Average weekly drinks	-.04	.03	-.27	-1.16	.07
No. Binge episodes	-.05	.07	-.18	-.76	.03
RAPI	-.06	.05	-.28	-1.21	.08
BAC post-Alcohol preload	25.82	38.37	.16	.67	.03
PANAS					
Positive Affect- Alcohol Condition	-.03	.05	-.13	-.57	.02
Negative Affect – Alcohol Condition	.11	.18	.15	.62	.02
Positive Affect – Placebo Condition	-.002	.05	-.01	-.04	<.01
Negative Affect – Placebo Condition	.06	.13	.11	.45	.01
Difference in Positive Affect between Conditions	-.07	.08	-.21	-.91	.04
Difference in Negative Affect between Conditions	>-.01	15	-.01	-.03	<.01
Desire for Alcohol					
Alcohol Condition	.04	.04	.26	1.15	.07
Placebo Condition	-.01	.05	-.05	-.19	<.01
Difference between conditions	.07	.04	.36	1.62	.13
Biphasic Effects of Alcohol					
Stimulating Effect - Alcohol Condition	.01	.03	.07	.27	<.01
Sedating Effect – Alcohol Condition	.06	.04	.32	1.44	.10
Stimulating Effect – Placebo Condition	>-.01	.03	-.04	-.16	<.01
Sedating Effect – Placebo Condition	.03	.05	.16	.69	.03
Difference in Stimulating Effects between Conditions	.01	.03	.11	.47	.01
Difference in Sedating Effects between Conditions	.08	.06	.28	1.25	.08

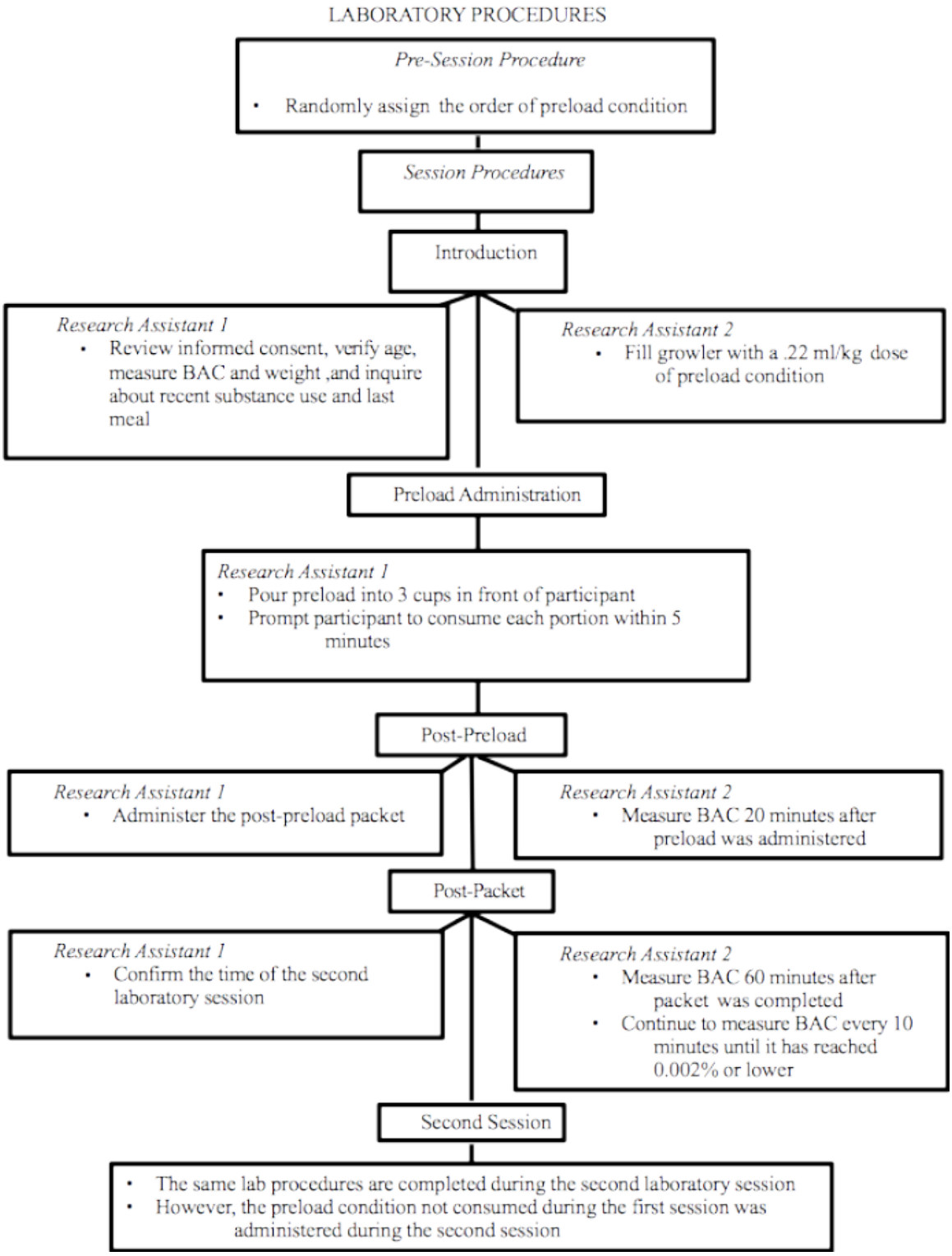
Note: * = p≤.05

Table 7
Regression Analyses of the Transformed Difference in Multiple Choice Procedures Crossover Points

Predictor	B	SEB	ß	T	R2
Drinking Motives					
Coping	.01	.02	.13	.54	.02
Social	.01	.01	.15	.62	.02
Enhancement	.01	.01	.15	.63	.02
Conformity	.04	.03	.36	1.64	.13
DDQ					
Average weekly drinks	>-.01	<.01	-.06	-.25	.004
No. Binge episodes	.01	.01	.18	.77	.03
RAPI	-.01	.01	-.30	-1.31	.09
BAC post-Alcohol preload	2.75	4.79	.13	.58	.02
PANAS					
Positive Affect- Alcohol Condition	<.01	.01	.02	.08	.000
Negative Affect – Alcohol Condition	.02	.02	.22	.96	.05
Positive Affect – Placebo Condition	<.01	.01	.09	.40	.01
Negative Affect – Placebo Condition	.01	.02	.08	.34	.01
Difference in Positive Affect between Conditions	-.01	.01	-.12	-.49	.01
Difference in Negative Affect between Conditions	.01	.02	.09	.38	.01
Desire for Alcohol					
Alcohol Condition	.01	<.01	.37	1.67	.13
Placebo Condition	.00	.01	-.02	-.07	<.01
Difference between conditions	.01	.01	.46	2.18	.21*
Biphasic Effects of Alcohol					
Stimulating Effect - Alcohol Condition	>-.01	<.01	-.10	-.44	.01
Sedating Effect – Alcohol Condition	.01	.01	.37	1.67	.13
Stimulating Effect – Placebo Condition	<.01	<.01	<.01	.01	<.01
Sedating Effect – Placebo Condition	.01	.01	.23	.98	.05
Difference in Stimulating Effects between Conditions	>-.01	<.01	-.12	-.50	.01
Difference in Sedating Effects between Conditions	.01	.01	.26	1.16	.07

Note: * = p<.05

Figure 1


LABORATORY PROCEDURES
Pre-Session Procedure
• Randomly assign the order of preload condition
Session Procedures
Introduction
Research Assistant 1
• Review informed consent, verify age, measure BAC and weight ,and inquire about recent substance use and last meal
Research Assistant 2
• Fill growler with a .22 ml/kg dose of preload condition
Preload Administration
Research Assistant 1
• Pour preload into 3 cups in front of participant
• Prompt participant to consume each portion within 5 minutes
Post-Preload
Research Assistant 1
• Administer the post-preload packet
Research Assistant 2
• Measure BAC 20 minutes after preload was administered
Post-Packet
Research Assistant 1
• Confirm the time of the second laboratory session
Research Assistant 2
• Measure BAC 60 minutes after packet was completed
• Continue to measure BAC every 10 minutes until it has reached 0.002% or lower
Second Session
• The same lab procedures are completed during the second laboratory session
• However, the preload condition not consumed during the first session was administered during the second session