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The effects of alcohol priming on subsequent preferences for alcohol and other drugs

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The Effects of Alcohol Priming on Subsequent Preferences for Alcohol and Other Drugs

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The Effects of Alcohol Priming on Subsequent Preferences for Alcohol and Other Drugs

Substance use may be characterized as a behavior (or set of behaviors) sensitive to its consequences. Within a context, there are particular stimuli that may elicit responses, and given all possible responses, the emitted behavior may be referred to as *choice*. The environment in which substance use takes place, the physical state of the user, and the qualities of the substance may all influence substance use choices. In certain contexts, substance use choices are more reinforcing than available alternatives, especially when those alternatives are uncertain or delayed (Donny, Bigelow & Walsh, 2004). That is, the value of, or preferences for, substances may vary under different conditions thus impacting choice behavior.

From an operant perspective, reinforcement parameters related specifically to substances are important when determining the reinforcing value of substances in a given context. For example, alcohol concentration and dose may influence consumption choices. In addition to dose (or magnitude), delay to reinforcer access, reinforcer quality, effort required to gain access to reinforcer, and certainty of access may also influence the reinforcing value of a substance. Similarly, the same reinforcement parameters are simultaneously at work with respect to alternatives. In order for alternatives to substance use to be among chosen behaviors (as opposed to substance use), reinforcement value associated with alternatives must *compete* with reinforcement associated with substance use. Research has demonstrated that the relative reinforcing efficacy of substances may be altered by a variety of variables including exteroceptive and interoceptive stimuli and events (e.g., Rousseau, Irons, & Correia, 2011).

Exteroceptive and Interoceptive Factors Influencing Substance Use

Several studies suggest a negative relation between reinforcement from drug-free activities and drug use. For example, Correia, et al. (2005) randomly assigned participants to one of three experimental conditions with corresponding behavioral instructions: substance use

reduction (SR), activity increase (AI), and a no-change control. Participants in the SR condition were instructed to decrease their substance use by 50% in the number of substance use days and participants in the AI condition were instructed to increase the number of days they engaged in both exercise/physical activity and creative/artistic activity, each by 50%. Participants assigned to both of these conditions reported a significant decrease in their substance use relative to baseline while the control group experienced no meaningful change in substance use. These results are consistent with other studies (e.g., Correia, Carey & Borsari, 2002; Correia, et al., 2003; Correia, et al., 1998) that suggest decreases in substance use and substance-related behaviors can be achieved by increasing the value of substance-free alternative reinforcers or by increasing engagement in substance-free behaviors.

In addition to consideration of exteroceptive factors (such as the manipulation of engagement in substance free activities) that may influence the value of substances relative to alternatives, interoceptive phenomena may also be important for understanding and predicting substance choices. For example, motives for use have been identified as an interoceptive influence likely to affect substance use. More specifically, several studies have highlighted the potential relation between negative mood states and substance use for coping (e.g., Lewis et al., 2008). Rousseau, Irons, and Correia (2011) randomly assigned participants to neutral or negative mood conditions and, following a mood induction procedure, asked them to make choices between ascending money choices (ranging from $0 to $20 in 50 cents increments) and alcohol (up to 2 standard drinks of alcohol) in effort to quantify the relative reinforcing value of alcohol. Results revealed a significant interaction between mood condition and coping motives such that alcohol was valued significantly more in the negative mood condition, but only among participants that reported high levels of drinking to cope. This study was the first to suggest that coping motives

are differentially predictive of the reinforcing value of alcohol. Subsequent studies have suggested that drinking motives, specifically enhancement and coping motives, mediate the relation between reinforcing efficacy and problematic alcohol use (Yurasek, et al., 2011). Using substances (i.e., alcohol, cigarettes, and marijuana) for negative reinforcement reasons, most notably coping motives, may represent a relatively maladaptive style of use that is associated with heavy and/or problem use (e.g., Cooper, 1994, Costa, et al. 1980 & Simons, et al., 1998).

In addition to mood, coping motives may be associated with a number of interoceptive phenomena implicated in substance use, including stress. Indeed, a substance may be conceptualized as a negative reinforcer when it functions to reduce stress. In one study, 50 participants experienced either the Trier Social Stress Test (TSST) or a no-stress control condition (reading a travel magazine), and then consumed beer under the guise of a taste test (Merrill & Thomas, 2013). Researchers looked at relations between drinking motives, adaptive coping (action oriented; involving altering the problem or environment that is causing the distress), and their interaction as predictors of milliliters of beer consumed in a clinical laboratory setting. Results revealed an interaction, such that coping motives and in-lab drinking following a stressor were most strongly positively correlated in the context of low adaptive coping skills (Folkman, Lazarus, Dunkel-Schetter, DeLongis, & Gruen, 1986). Another study revealed that exposure to a stressor led to a significant attentional bias (delayed responding) for alcohol-related cues (during a visual probe task), but only among participants who self-reported 'drinking to cope' as a prominent motive for drinking (Field & Powell, 2007). Additionally, studies have shown that coping motives are associated with levels of marijuana use (Bonn-Miller, et al., 2007) and marijuana-related problems (Simons, et al., 2005; Lee, et al., 2007). Among chronic users of marijuana, stress has been shown to be a significant contributor to

maintenance of use (McRae-Clark, et al, 2011). One study reported stress relief as the most commonly cited benefit from and reason for continuing marijuana use (Copeland, et al, 2001). The concept of anxiety sensitivity (AS) may also be of importance for understanding substance use. AS (a cognitive-affective vulnerability factor) is defined as a relatively stable individual difference factor reflecting fear of arousal-related sensations, which arises from beliefs that these sensations have harmful personal consequences (Reiss & McNally, 1985). Studies suggest AS is related to coping-oriented motives for cigarette smoking (Brown et al., 2001 and Zvolensky et al., 2005), alcohol consumption (Conrod et al., 1998, Stewart et al., 1997 and Stewart et al., 2002) and marijuana use (Bonn-Miller, et al., 2007).

Alcohol priming and the current study

To date, most research has focused on exteroceptive conditions and interoceptive cognitive phenomena in effort to understand substance choices. More recent research has begun to examine the effects of substance exposure (i.e., priming) on subsequent preferences for substances (both across and within drug). Priming can be characterized as an exteroceptive stimulus that leads to interoceptive events, some of which may be reinforcing and thus influence subsequent use. It is important to understand the reinforcing efficacy of substances while under the influence of substances because people often report making uncharacteristic choices, some of which are unhealthy or dangerous, when they are under the influence of substances (Parks, Pardi & Bradizza, 2005). Previous literature suggests that abstinent drug users who consume even a small amount of their previously used drug are more likely to continue using or resume regular usage of the drug (e.g., de Wit, 1996). This effect seems to occur even after long periods of abstinence. Additionally, some literature has suggested that a priming dose of ethanol or other substance in nonclinical samples characterized as social users increases subjective desire for the

drug compared to alternative reinforcers (de Wit & Chutuape, 1993; Chutuape, et al., 1994). This priming effect may elicit previously unintended subsequent use such as binge drinking. Understanding the potential priming effects of alcohol among social drinkers may help explain subsequent use choices that may lead to binge drinking and/or prolonged abuse. Further research may lead to strategies for reducing the reinforcing efficacy of consuming more of a substance while under the influence of substances.

Fillmore and Rush (2001) examined the relation between alcohol priming and performance on a stop-signal task to acquire alcohol and money as reinforcers. Participants were randomly assigned to receive alcohol or placebo, and within these groups they were randomly assigned to perform the task under one of two reinforcement conditions: alcohol versus high monetary reward or alcohol versus low monetary reward. Participants could obtain access to reward (alcohol or money) if they inhibited their responses relative to baseline testing and if they responded more quickly to the go-signals than at baseline. Results showed that alcohol preload increased preference for alcohol when alternative reinforcers (i.e., low monetary reward) are of little value. Fillmore and Rush posited that moderate doses of alcohol can increase subsequent alcohol consumption and that this effect is dependent on the availability and value of other reinforcers in the environment. Priming effects may be a result of an interaction between internal events and environmental ones.

Similarly, de Wit and Chutuape (1993) examined choice regarding alcohol versus monetary incentives after a preload dose of alcohol. Following a preliminary session during which participants tested both the alcohol and placebo beverages, they were asked to report their preference. If participants chose the alcohol beverage, the experimenter asked, “If I were to offer you a monetary incentive to take the other substance, how much would it take for you to switch

your choice?" The experimenter started at one dollar and when the participant crossed over from alcohol to money they received the money. The same procedure was completed after a placebo dose, a .25g/kg preload dose, and a .5g/kg preload dose. Analyses revealed a significant linear trend; as the preload dose increased, more participants initially chose ethanol. Additionally, ratings of desire for the ethanol-containing beverage increased following exposure to the higher preload.

In summary, there is some evidence to suggest that a preload priming dose of alcohol increases subsequent value of or preference for alcohol. The current study aims to examine the effects of a priming dose of alcohol, relative to placebo, on behavioral choice for additional alcohol relative to money. A secondary aim of the study involves examination of hypothetical preference for nicotine and marijuana following the alcohol priming dose relative to placebo.

Method

Participants

We recruited 48 undergraduate students using criterion sampling. Participants self-reported having consumed at least four alcoholic beverages in the past 28 days, on at least one occasion drank the equivalent of two standard drinks, and were at least 21 (verified with government-issued ID if included in the study). Students who used prescription drugs for mental or physical reasons were not asked to participate in this study. The Irons Laboratory uses a Central Screener (IRB#13-0223) to identify potential participants who may meet criteria for lab-based studies. We recruited by emailing respondents to the central screener who met the noted criteria above (recruitment for the screener is via campus-wide emails distributed by the Registrar). All participants provided informed consent prior to participating. Volunteers

received $15 for their participation. This study was approved by the James Madison University Institutional Review Board.

Materials

Self-Report Measures. Participants completed the following web-based self-report questionnaires.

Alcohol Timeline Followback Calendar (TLFB-A). This measure is used to assess self-reported alcohol use (Sobell, L.C. & Sobell, M.B., 1996). The survey appears in calendar format with room for participants to report the number of standard drinks in numerical form. A chart at the top of the calendar indicates what is considered a standard drink (12 ounces of beer, 5 ounces of wine and 1.5 ounce shot of hard liquor). Test-retest reliability studies indicate significant correlations for frequency of days drinking and maximal daily quantity over a thirty day period (Carey, K.B., 1997)

Daily Drinking Questionnaire (DDQ). This measure is used to assess typical drinking behavior. Respondents fill in boxes representing each day of the week with the number of drinks they typically consume on that day and the maximum number of drinks they have consumed on that day. Data from the DDQ and the Drinking Practices Questionnaire are significantly correlated ($r(52) = .50$ $p=.001$) (Collins, Parks, & Marlatt, 1985).

Rutgers Alcohol Problem Index (RAPI). This measure is used to assess alcohol related problems among participants. The Likert-type survey includes a number of negative behaviors and the participant is to report how many times the behavior has occurred because of alcohol use (0 indicates never, 4 indicates 10 or more times). Longitudinal studies show moderately strong correlations between RAPI and alcohol use intensity suggesting that this measure is a valid and useful tool in assessing problem drinking (White & Labouvie, 1989).

Drinking Motives Questionnaire (DMQ). This measure is used to evaluate reasons for alcohol consumption. Respondents address a number of questions regarding their reasons for consuming alcohol. Participants indicate how often the item applies to them on a Likert-type scale of 'almost never/ never' to 'almost always.' This measure is valid and reliable in investigating drinking motives of young adults (Stewart, Zeitlin & Samoluk, 1996).

Daily Exercise Questionnaire (DEQ). This measure indicates participant exercise habits. The survey asks if the respondent has participated in 30 minutes or more of strenuous, moderate and light physical activity in the last 24 hours and leaves space for the respondent to report how many times and what type of exercise they completed as well as a brief description of the activity.

Positive and Negative Affect Scale (PANAS). This measure is used to evaluate participants' moods before the experimental procedure. Positive affect (feeling enthusiastic, active and alert) and negative affect (feeling anger, contempt, disgust, guilt, etc.) are the two dominant dimensions that consistently emerge in studies of mood and affective structure. The survey includes a number of words that describe different feelings and emotions and respondents indicate the extent to which they feel that way at present. PANAS is a valid and reliable scale that is also brief and easy to administer (Watson & Clark, 1988).

Self-Report Measures. Participants completed the following self-report questionnaires with pencil and paper.

Multiple Choice Procedure (MCP). This measure is a highly efficient procedure for investigating relative reinforcing efficacy of drugs in humans (Griffiths, Troisi, Silverman, & Mumford, 1993). The respondent is provided with three forms. The first form presents a series of choices between a standard alcohol drink and ascending dollar amounts ($0.00 - $20.00), the

second between marijuana and ascending dollar amounts, and the third between a cigarette and ascending dollar amounts. Participants were instructed to highlight which option they prefer (i.e. money or alcohol) on 45 different choices per form. The point at which the participant "crossed over" from selecting substance to money was our primary outcome variable. As a validity check, all of the choices on the MCP are numbered and those numbers are put into a common source to be randomly drawn by participants and consequated by experimenters. For the current study, only the alcohol form was consequated; the marijuana and cigarette choice forms were hypothetical (Chutuape et al., 1998). The MCP is a valid and efficient contingency-based measure of drug reinforcement (Griffiths, Rush & Puhala, 1996). See Procedures below for more detail.

Session day intake. Participants were asked to report their caffeine, alcohol, nicotine and food intake for the day.

Alcohol estimation. Participants completed a beverage rating scale to report their perceived alcohol content of their beverages in terms of standard drinks and current BAC. This scale is useful in determining whether participants who receive a placebo are able to detect that no alcohol had been received (Fillmore & Vogel-Sprott, 2000).

Biological measures of Substance Use.

Blood Alcohol Content Monitor. The Lifeloc FC10 Plus Breathalyzer was used to determine the blood alcohol levels of the participants throughout the study.

CO monitor. Portable Breath CO monitors (Vitalograph Inc., Quivira, KS) measured parts per million (ppm) of CO in breath sample as well as smoking status. CO samples allow for detection of recent smoking (within the last 7-10 hours). A score of 0 ppm indicated no smoking and higher CO scores indicate greater CO in the breath and thus more smoking.

ETOH and placebo beverage materials.

Beverage preparation. The dose of ETOH is 1.5 ounces of whiskey in a seltzer and lime mix. The placebo beverage is 1.5 ounces of Arkay artificial whiskey in a seltzer and lime mix. 1 ml of alcoholic whiskey and .6ml of bitters were floated over the top of the placebo to serve as a taste mask. The beverages were approximately 13.5 ounces and were served over ice in plastic cups.

In the event that participants drew an MCP choice for which they preferred alcohol, they were offered beer, vodka, or whiskey as subsequent drink choices with cranberry juice, diet or regular soda as mixers.

Procedure

Participants who were at least 21 years old, had consumed at least four alcoholic beverages in the past 28 days, and who on at least one occasion had consumed at least the equivalent of 2 standard drinks were eligible participate in the study. Each participant came to the laboratory for one 4-hour session. We recruited by emailing respondents to the central screener who met the noted criteria above (recruitment for the screener is via campus-wide emails distributed by the Registrar).

Participants who chose to enroll in the study were asked to refrain from eating two hours prior to the session. Upon arrival to the session, participants signed an informed consent form. For safety reasons they were given a Breathalyzer test to confirm a BAC of .000. The participants then completed a set of surveys including the DDQ, DMQ, RAPI, PANAS, Alcohol TLFB, and DEQ. Participants also reported how much alcohol and caffeine they had consumed that day as well as what they had eaten. While the participant completed the surveys, Research Assistant A randomly assigned the participant to receive alcohol or placebo. Research Assistant

B administered the beverage when the surveys were completed. The administration was double-blind such that the Research Assistant B, who administered the beverage, did not know whether the beverage was alcohol or placebo. The participant was instructed to consume the beverage within 5 minutes after which he or she watched a brief video to allow time for the alcohol to take effect.

After the video, BAC was measured again and the participant completed the Alcohol Estimation measure. The participant also completed the MCP forms for alcohol, marijuana and nicotine. The research assistant explained that the participant would actually receive one of the choices made on the MCP for alcohol; however, the nicotine and marijuana choices were hypothetical. The participant was instructed to imagine him or herself in a situation where he/she would usually enjoy alcohol, nicotine or marijuana. Then, the participant drew one of his/her choices from the alcohol MCP and he/she received the choice they indicated by the number they drew. If they drew money it was given to them immediately, and if they drew alcohol they had a choice of whiskey, vodka, or Bud Light. Mixers were provided.

The participant remained in the lab for the remainder of the 4-hour session and until his/her BAC returned to .000. Every half hour a research assistant measured his/her BAC. At the end of the session, the participant received $15 compensation and a Referral Services handout.

Results

Participants included 13 males and 35 females, ages 21-24 (M = 21.21, SD =.55). See table 1 for descriptive statistics. An independent t-test served as a validity check for the placebo beverage; the test revealed no differences between alcohol (M = 1.53, SD = .67) and placebo (M

= 1.40, *SD* = .65) group means with respect to estimated beverages on the Alcohol Estimation questionnaire.

Independent t-tests revealed no significant differences between alcohol (*M* = $6.29, *SD* = $3.91) and placebo (*M* = $5.93, *SD* = $3.77) group means with respect to relative reinforcing value of alcohol, between alcohol (*M* = $3.08, *SD* = $4.69) and placebo (*M* = $2.76, *SD* = $4.43) with respect to relative reinforcing value of marijuana, or between alcohol (*M* = $0.23, *SD* = $0.75) and placebo (*M* = $1.02, *SD* = $1.95) with respect to relative reinforcing value of nicotine. Independent t-tests also revealed no significant differences between female (*M* = $6.19, *SD* = $3.97) and male (*M* = $5.90, *SD* = $3.43) group means with respect to relative reinforcing value of alcohol, between females (*M* $2.54, *SD* = $4.31) and males (*M* = $3.94, *SD* = $5.07) with respect to marijuana, or between females (*M* = $0.56, *SD* = $1.34) and males (*M* = $0.81, *SD* = $1.97**)** with respect to nicotine.

A series of factorial ANOVAs revealed no significant main effects of or interactions between condition (alcohol or placebo) and gender (female or male) with respect to the relative reinforcing value of alcohol (covariates: calculated BAC and DMQ enhancement score) (see Figure 1), marijuana (covariates: calculated BAC and RAPI score)(see Figure 2) or nicotine (when controlling for calculated BAC and RAPI score) (see Figure 3). Covariates were empirically derived (see Table 2) as well as informed by theory and previous literature. G*Power software was used to calculate needed sample size (*N* = 266) for sufficient statistical power (.95) given the observed effect size (.22).

Discussion

The current study employed a behavioral choice procedure to examine the effects of alcohol priming on the relative reinforcing value of substances. We sought to replicate previous

results that indicated an increased preference for alcohol among social drinkers after a preload dose. In addition to the value of alcohol following a preload dose, we examined hypothetical choices intended to measure the value of marijuana and nicotine. Data revealed no evidence of a priming effect as discussed in previous literature; however, data revealed a consistent pattern of responding across all three substance preference measures suggesting that males and females differ with respect to the value of substances following priming, but only in one study condition. Females valued all substances more so than males, but *only* in the alcohol condition. Though not statistically significant, there may be a potentially clinically relevant interaction of study condition and gender with respect to the value of substances following a priming dose.

The Current Study Results in Context

In contrast to previous work, our data did not reveal a priming effect of alcohol; however the reinforcing value of alcohol and marijuana (though not nicotine) were higher, as expected, in the alcohol condition relative to placebo condition. Results inconsistent with the extant literature may be a result of several potential explanations. The current study dosed participants with a single standard drink (holding dose constant) while previous work typically dosed using a mg/kg procedure (holding BAC constant). It is possible that one standard drink is not sufficient to elevate BAC levels high enough to experience priming. Alternatively, the dependent measure for the current study, MCP crossover points indicating the value of alcohol, may not be sensitive to the effects of priming. In addition, the current study only examined undergraduate college students; in contrast, previous studies involving alcohol priming included participants between ages 21-35, not specific to a college population, which may contribute to the inconsistencies in our findings relative to previous work. Further, it is plausible that given greater statistical power the observed trend may reach statistical significance and thus consistency with previous data.

As noted, females valued alcohol and marijuana more so than males, but only after alcohol preload. Previous literature suggests a positive relation between the strength of the priming effect and the alcohol preload dose (Chutuape, Mitchell & de Wit, 1994). On average, females reached a higher BAC from one standard alcohol drink than did males and thus were more likely to experience priming effects. As such, females may be more likely than males to experience the priming effect in social situations given that one standard drink leads to higher BAC among females than males. To the extent that priming may function to facilitate excessive drinking, such differences may be of clinical relevance. Males and females also differ with respect to motives related to alcohol consumption. Previous literature suggests that males are more likely than females to report drinking to increase positive affect or to socialize and affiliate with others (Stewart, Zeitlin & Samoluk, 1996). It is possible that gender differences in motives for substance use may have affected preference for alcohol in the current study; however, data do not reveal statistically significant gender differences for any of the four sub-scales of the DMQ (see Table 3). Although gender groups were equally distributed between study conditions, it is important to note that the current study had more female participants (n = 35) than male (n = 13). A more balanced sample with respect to gender may help in effort to replicate and/or explain the gender effect in the present study.

Strengths and Limitations

The current study included a number of strengths and limitations. Random assignment to study conditions allowed for increased likelihood that groups were similar with respect to alcohol preference before the onset of the study. The use of placebo rather than a non-alcoholic beverage helped to eliminate expectancy effects related to alcohol consumption. Expectancies are important for understanding drinking patterns as well as behavior in drinking situations

(Southwick, Steele, Marlatt & Lindell, 1981) and thus, eliminating expectancy effects was an important control. As a validity check for the efficacy of our placebo, participants completed an Alcohol Estimation questionnaire for which they were asked to report how much alcohol they believed they consumed. Participants were unable to discern the absence of alcohol in our placebo.

We employed a standardized protocol to reduce researcher error, within and across sessions as well as within and across researchers. The administration of alcohol in a standard drink functions as both a strength and limitation. The use of a standard drink allowed for a constant dose of alcohol thus more closely mirroring a real-world drinking situation, in comparison to a mg/kg method of administering alcohol. Though potentially advantageous with respect to external validity, on average, participants only reached a BAC of .024 after one standard drink. Although previous literature has suggested that priming effects may occur after this small priming dose, one standard drink may have been insufficient for participants to experience priming effects, especially among males. The use of the mg/kg method of administering alcohol would allow researchers to hold BAC constant such that examination of standard BAC (as opposed to standard dose) on priming could occur.

Also related to standardization, participants were instructed to imagine themselves in a setting in which they would typically ingest substances while responding to the MCP. Though all participants received the same instructions for completing the MCP, the contexts in which they typically ingest substances may vary and thus influence preference. For example, if one participant drinks in an upscale bar most often, he/she may be willing to pay more for another drink (higher crossover point) in comparison to a participant who most often drinks from a case of beer at home. Future studies may benefit from specifying a context in which participants

should be envision themselves and/or adding a context question to consider as a statistical control.

Our use of college students is both a potential strength and weakness. By limiting our sample to college students, we reduced variability in alcohol preference with respect to participant characteristics. Also, though our sample is limited to college students, the priming effect may be of particular relevance among this population. College students are considered an at-risk group for alcohol use and abuse. Data from the Monitoring the Future project (as cited in Ham & Hope, 2002) indicate that 84.2% of college students report having experienced at least one heavy drinking episode (4-5 drinks in a single drinking occasion) in the 90 days previous to survey. Young adults who engage in binge drinking are at an elevated to risk for experiencing alcohol-related problems (e.g., unsafe sex, injury, driving while intoxicated, impaired academic performance; Wechsler, Dowdall, Davenport, & Rimm, 1994). Additionally, students who do not binge drink but live on high-binge campuses were twice as likely to report being assaulted, awakened, or kept from studying by drinking students, than non-binge drinkers and abstainers at low-binge campuses (Wechsler et al,. 2000). Understanding the priming effect may be important for understanding heavy episodic alcohol consumption; however, more data are necessary to fully elucidate whether the priming effect occurs, under what conditions, and for whom such that replication is needed both to verify the current study findings as well as to determine the potential for generalizability beyond a college student population.

The current study is the first known investigation of the effects of a preload dose of alcohol on behavioral choice. Replication is warranted to fully understand the priming phenomenon. Future studies might consider the effects of two standard drinks on subsequent choices; perhaps priming only occurs once a particular threshold of intoxication has been

reached. Further, researchers might also consider a within-subjects comparison to examine the effects of alcohol preload on subsequent preferences. Current study data suggest that there may be a gender effect associated with priming such that future studies should also examine such a relation. Further data are necessary to confirm whether the priming effect is present after ingestion of one standard drink as well as to examine potential gender effects.

Table 1

Demographic characteristics of the sample

Demographic	
Age (mean)	21.21 (.55)
Sex (% female)	73
Weight (mean lbs)	
Male	178.5 (32.98)
Female	140.66 (25.61)
Education (% of participants)	
College Junior	44.9
College Senior	49
Graduate student	2
Race (% of participants)	
Caucasian	77.6
African American	4.1
Asian	8.2
Other	6.1
Cigarette Smokers (% who smoke)	4

Note. Values in parentheses represent standard deviations.

Table 2

Correlations between mean MCP crossover points, PBS sub-scores, RAPI score, DMQ sub-scores, AUDIT score, estimated and calculated BAC

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1. Mean Alcohol Crossover	-	.43**	.39**	-.37*	-0.24	-0.08	.32*	.35*	.31*	.48**	0.25	0.20	0.07	0.02
2. Mean Marijuana Crossover	.43**	-	.63**	-0.23	-0.13	-0.09	.46**	0.20	0.14	0.17	0.10	0.16	0.27	0.01
3. Mean Nicotine Crossover	.39**	.63**	-	-0.09	0.03	0.13	.42**	0.11	0.002	0.09	0.13	0.13	-0.03	-0.26
4. Limitdrink sub-score of PBS	-.37*	-0.23	-0.09	-	.64**	.36*	-0.22	-.389**	-.44**	-.35*	-.38**	-.33*	-.30*	0.01
5. Mannerdrink sub-score of PBS	-0.24	-0.13	0.03	.64**	-	.57**	-0.13	-.47**	-.31*	-.33*	-.42**	-0.17	-0.12	-0.003
6. Harmred sub-score of PBS	-0.08	-0.09	0.13	.36*	.57**	-	-0.11	-.32*	-0.17	-0.07	-0.21	-0.11	-0.28	-0.13
7. Total RAPI score	.32*	.46**	.42**	-0.22	-0.13	-0.11	-	.38**	0.28	.44**	.37*	.47**	0.19	-0.18
8. DMQ Social Score	.35*	0.20	0.12	-.39**	-.47**	-.32*	.38**	-	.79**	.73**	.70**	.32*	0.12	0.06
9. DMQ Coping Score	.31*	0.14	0.002	-.44**	-.31*	-0.17	0.29	.79**	-	.74**	.67**	.30*	0.27	0.05
10. DMQ Enhancement Score	.48**	0.17	0.09	-.35*	-.33*	-0.07	.44**	.73**	.74**	-	.65**	0.24	0.10	0.11
11. DMQ Conformity Score	0.25	0.1	0.13	-.38**	-.42**	-0.21	.37*	.70**	.67**	.65**	-	.42**	0.01	-0.11
12. Total AUDIT Score	0.20	0.16	0.13	-.33*	-0.17	-0.11	.47**	.32*	.30*	0.24	.42**	-	0.07	-0.20
13. Mean Estimated BAC	0.07	0.27	-0.03	-.30*	-0.11	-0.28	0.19	0.12	0.27	0.10	0.01	0.07	-	.40**
14. Mean Calculated BAC	0.02	0.01	-0.26	0.01	-0.003	-0.13	-0.18	0.06	0.05	0.11	-0.11	-0.19	.40**	-

[a](*) indicates significance at the .05 level
[b](**) indicates significance at the .01 level

Table 3

Means and standard deviations for males and females on PBS sub-scores, RAPI, DMQ sub-scores, and AUDIT score

	Male		Female		Total	
	M	*SD*	*M*	*SD*	*M*	*SD*
Limitdrink	18.1	7.1	20.8	6.1	20.13	6.4
Mannerdrink	15.0	2.26	15.94	3.42	15.7	3.17
Harmred	9.67	4.56	11.22	5.16	10.83	5.01
Total_RAPI	6.91	6.72	4.29	2.86	4.96	4.26
DMQ_Social	12.16	4.1	11.23	3.01	11.47	3.30
DMQ_Coping	12.67	2.74	13	3.69	12.91	3.45
DMQ_Enhance	10.12	2.75	9.67	3.04	9.72	2.95
DMQ_Conform	13.75	3.69	13.11	3.25	13.28	3.34
Audit_total	10.08	3.02	7.57	4.12	8.21	3.99

Note. *M* = mean, *SD* = standard deviation

Figure 1

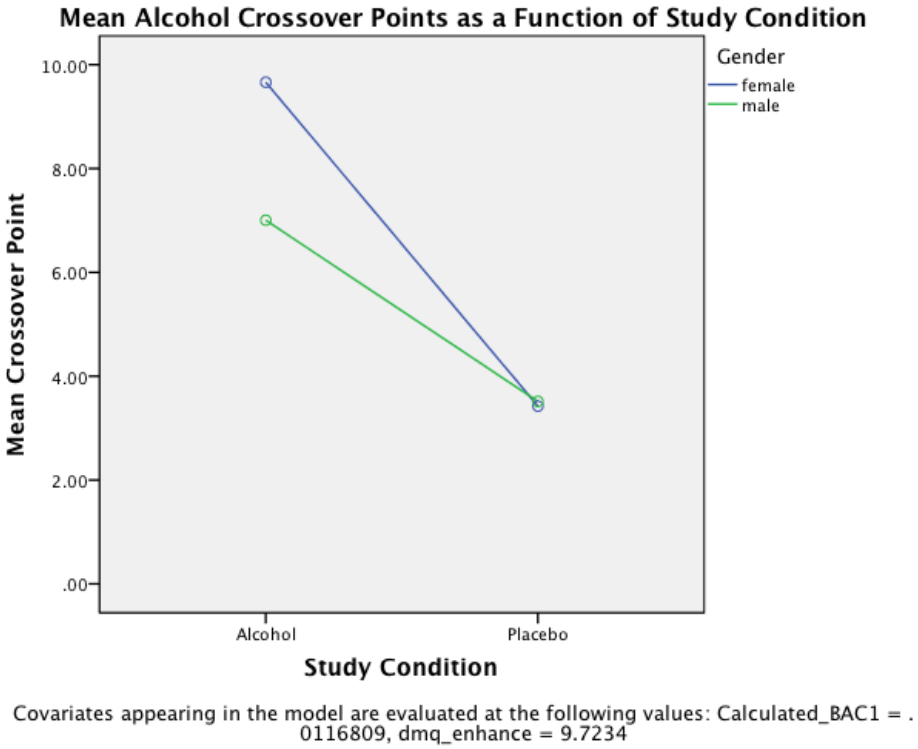

Figure 1. The mean crossover points for the alcohol MCP (dollar values) as a function of study condition (alcohol or placebo).

Figure 2

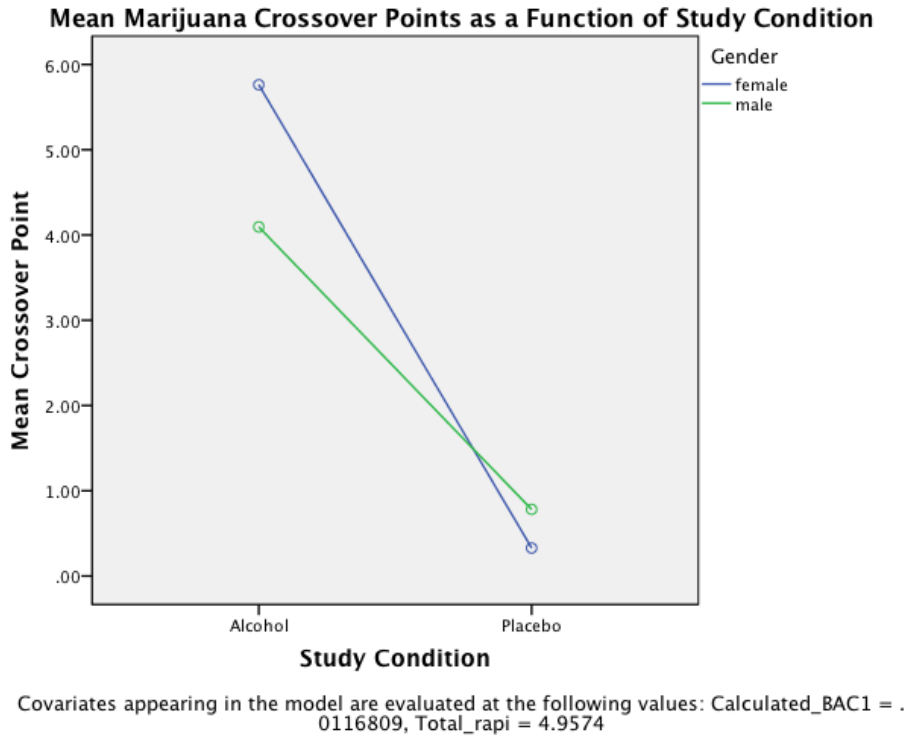

Figure 2. The mean crossover points for the marijuana MCP (dollar values) as a function of study condition (alcohol or placebo).

Figure 3

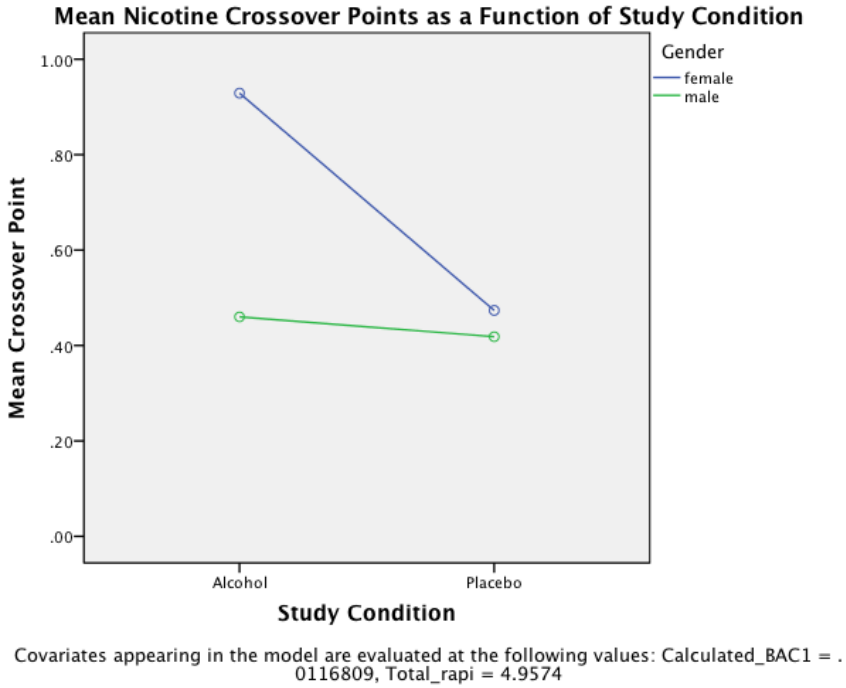

Figure 3. The mean crossover points for the nicotine MCP (dollar values) as a function of study condition (alcohol or placebo).

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