Published in final edited form as:

Pers Individ Dif. 2009 May 1; 46(7): 693–698. doi:10.1016/j.paid.2009.01.024.

Craving Predicts Within Session Drinking Behavior Following Placebo

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Abstract

Tiffany's (1990) cognitive processing model postulates that craving will only occur when access to alcohol is blocked. To test a hypothesis based on this model, we analyzed data from a naturalistic laboratory alcohol challenge study involving moderate-to-heavy drinking young adults ($N = 174$) with a focus on the placebo beverage condition of this study. Our hypothesis was that self-reports of "wanting more alcohol" (i.e., craving) in the lab, following placebo, would predict subsequent ad libitum consumption because placebo administration would constitute partial blocking of access to alcohol. We also tested the possibility that craving might mediate associations between personality traits and ad libitum consumption. Both trait disinhibition and reports of craving following the placebo beverage significantly predicted ad libitum consumption. Further, craving partially mediated the association between trait disinhibition and ad libitum consumption. Potential implications of these findings are discussed.

Keywords

Alcohol; alcohol challenge; craving; disinhibition; harm avoidance; impulsivity; inhibition; placebo

1. Introduction

Craving has long played a central role in theories concerning the development and maintenance of alcoholism (Tiffany, 1990; Verheul, Van Den Brink & Geerlings, 1999). Associations between self-reported craving and alcohol use, however, have been inconsistent (Drummond, 2001; Tiffany, 1990). For instance, Bottlender and Soyka (2004) reported that craving predicted subsequent relapse in a sample of alcohol dependent individuals in outpatient treatment. In contrast, in another study, only 7% of patients who had relapsed in a rehabilitation program identified craving as a cause (Miller & Gold, 1994). A number of theoretical models have been proposed to address the complex relation between craving and alcohol use. Some

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theoretical models have hypothesized that individual differences may affect the experience of craving and substance use (e.g., Verheul et al., 1999), whereas others have aimed to differentiate the relative roles of unconscious, automatic processes from conscious, deliberate processes involved in obtaining and consuming alcohol (Robinson & Berridge, 2001; Tiffany, 1990). In his cognitive processing model, Tiffany (1990) postulates that when alcohol seeking behaviors have become well practiced, they can eventually become unconscious and automatic. This process is set in motion by stimulus triggers, which can be internal (e.g., stimulating effects of the substance) or external (e.g., alcohol-related cues). In the Tiffany model, craving is viewed as a conscious, higher order cognitive process that is activated when efforts to obtain alcohol are blocked either externally (e.g., the liquor store is closed) or internally (e.g., use of coping skills to avoid drinking).

Although Tiffany's (1990) model pertains directly to dependent individuals, it may also apply to frequent social drinkers. These individuals consume alcohol regularly in stereotyped environments (e.g., bars, parties), which contain drinking cues (e.g., other young people drinking, beer glasses). Thus, it stands to reason that alcohol consumption can become a well-practiced activity for a frequent social drinker, in the manner described by Tiffany. Accordingly, in a manner similar to what has been observed in dependent individuals (see Franken, 2003), positive correlations have been found between magnitude of attentional bias to alcohol-related cues and self-reported craving for alcohol in social drinkers (Field, Mogg, & Bradley, 2005).

Alcohol challenge studies often include a placebo control condition, in which participants are placed in a drinking context but do not receive alcohol. In this situation, access to alcohol is blocked, which should result in heightened craving according to Tiffany's model. To the extent that conscious craving is an important predictor of behavior, those who experience stronger craving after placebo administration should subsequently drink more than those with lower levels of craving. Whereas participants in a placebo condition will not necessarily be consciously aware that their access to alcohol is being blocked, we nonetheless believe that placebo beverage administration constitutes partial "blocking" from alcohol. Evidence has shown that placebo beverage participants tend to report weaker alcohol-related effects (e.g., subjective intoxication) than participants administered alcohol (Maisto, Carey, Carey, & Gordon, 2002; Marczinski & Fillmore, 2005). We posit that blocking will be partial because participants will believe that they are consuming real alcohol, thus triggering alcohol-related expectancies, though to a lesser degree than those administered alcohol (Testa et al., 2006). Relative to participants assigned to placebo, those who receive alcohol should experience less craving and reports of craving should not be strongly associated with further consumption.

In addition to being context specific, individual differences in craving have been observed, irrespective of context. Verheul et al. (1999) postulated a three-pathway model of craving with the individual pathways thought to be caused by a combination of biological factors and personality traits. *Reward craving* is thought to be associated with reward seeking behavior, however, empirical findings linking reward seeking or reward sensitivity to alcohol use have been inconsistent (Sher, Wood, Vandiver, & Crews, 1995). *Relief craving* is thought to be linked with high behavioral inhibition, sensitivity or reactivity toward negative reinforcement. Consistent with this idea, tension reduction motives have been found to predict heavy drinking (Rutledge & Sher, 2001). *Obsessive craving* is thought to be associated with trait disinhibition. Findings associating aspects of trait disinhibition with young adult problem drinking are common. For instance, both sensation seeking (e.g., Justus, Finn, & Steinmetz, 2000) and impulsivity (e.g., Patock-Peckham & Morgan-Lopez, 2006) have been associated with alcohol use and related problems in undergraduate samples.

The current study was a naturalistic laboratory alcohol challenge with random assignment to either an alcohol or placebo beverage, followed by ad libitum alcohol consumption in moderate-to-heavy social drinkers. Based on Tiffany's model, we hypothesized that craving would be significantly higher after placebo than after alcohol, and that craving would predict ad libitum consumption following placebo, but not following alcohol administration. Given that trait disinhibition is posited as a cause of obsessive craving in the Verheul et al. (1999) model, we hypothesized that craving would mediate the relation between trait disinhibition and ad libitum consumption. We also tested the hypothesis based on the concept of relief craving that craving would mediate associations between harm avoidance/inhibition and ad libitum drinking. No predictions were made regarding reward craving given inconsistent previous findings pertaining to reward dependence and alcohol use (e.g., Sher et al., 1995).

2. Methods

2.1. Participants

Male and female (50.3%) participants ($N = 174$) between the ages of 21 and 30 ($M = 22.17$; $SD = 3.37$) were recruited through the campus newspaper at The University of Texas at Austin. To qualify, participants had to report consuming five or more drinks for men (four or more for women) on at least one day of a typical week during the past month. Participants with contraindications to alcohol consumption (e.g., symptoms of alcohol dependence, pregnancy) were not accepted into the study. The majority of participants were Caucasian (69%), followed by Latina/o (14.4%), Asian-American (6.3%), African-American (3.4%), multi-ethnic (4.0%), and other (2.9%). This study was approved by the Institutional Review Board for protection of human subjects at The University of Texas at Austin.

2.2. Measures

Alcohol Use at Baseline—The *Timeline Follow-back* (TLFB; Sobell & Sobell, 2003) interview was used to assess alcohol use during the past 30 days. The TLFB is a structured interview that uses a calendar with memory prompts (e.g., holidays) to help participants recall how much alcohol they consumed on each day. Data collected with the TLFB have been shown to be reliable and valid for up to 12 months (Sobell & Sobell, 2003). Responses on the TLFB were used to derive estimates of typical weekly alcohol consumption.

Baseline Personality Measures—The *Eysenck Personality Questionnaire Revised* (EPQ-R; Eysenck & Eysenck, 1992) is a 106-item scale designed to assess personality based on a “big three” model. The EPQ-R includes three factor analytically derived subscales with Cronbach's alphas of .72 (extraversion), .89 (neuroticism), and .69 (psychoticism). Impulsivity and sensation seeking were assessed using the *Zuckerman Kuhlman Personality Questionnaire III-Revised* (ZKPQ-III; Zuckerman, Kuhlman, Joireman, Teta, & Kraft, 1993), which demonstrated adequate internal reliability for both sensation seeking ($\alpha = 0.77$) and impulsivity ($\alpha = .71$). An abbreviated version of the *Tridimensional Personality Questionnaire* (Short TPQ; Sher et al., 1995) was used to assess novelty seeking, harm avoidance and reward dependence. Internal reliabilities ranged from .59 to .84. The *Behavioral Inhibition System/Behavioral Activation System* (BIS/BAS; Carver & White, 1994) is a 24-item measure of sensitivity to punishment and reward. The BIS is a unitary scale ($\alpha = 0.76$) and the BAS consists of drive, fun seeking and reward responsiveness subscales ($\alpha = .76$, $\alpha = .73$, and $\alpha = .59$, respectively).

A principal components analysis with varimax rotation was used to assess the extent to which the 12 variables derived from the personality measures could be grouped into a smaller number of factors. Cronbach's alpha was then used to assess the internal consistency of each factor. Three factors emerged with eigenvalues greater than one: (a) trait disinhibition (eigenvalue = 2.99, $\alpha = 0.79$), which included (rotated factor loadings in parentheses) psychoticism (0.80),

impulsivity (0.77), novelty seeking (0.75) and sensation seeking (0.73); (b) harm avoidance/inhibition (eigenvalue = 2.55, $\alpha = 0.85$), which included neuroticism (0.91), harm avoidance (0.89) and behavioral inhibition (0.79) and (c) reward dependence (eigenvalue = 2.15, $\alpha = 0.51$), which included reward responsiveness (0.69), extraversion (0.65), drive (0.63) and reward dependence (0.47). Fun seeking was eliminated due to high loadings on both trait disinhibition (0.59) and harm avoidance/inhibition (0.62). For trait disinhibition and harm avoidance/inhibition, individual variable scores were standardized and means were then taken. Reward dependence was eliminated due to its low internal reliability.

Craving—A single-item visual analog scale (Johanson & Uhlenhuth, 1980) was used to assess reports of “wanting more” alcohol after beverage administration. Craving was scored from 0 to 100 based on where participants marked a 100-mm line anchored by “not at all” and “extremely.”

Ad libitum alcohol consumption—Consumption was measured in standard drink units adjusted to account for drinks that were ordered but not consumed because participants had reached the maximum allowable blood alcohol concentration (BAC) of .12 g%. For individuals who ordered drinks that they could not consume, the ordered amount was added to the amount they actually consumed.

2.3. Procedures

Each participant was randomly assigned to consume either alcohol or taste-masked placebo. In groups of 2-4 participants, each individual was given 10 minutes to consume each of 3 drinks in a simulated bar. The drinks consisted of either 80-proof vodka or placebo (i.e., decarbonated tonic) mixed with Cherry 7-Up and lime juice. For the alcohol dose, drink volumes were adjusted according to weight and gender to reach a target BAC of 0.06 g%. For the placebo group, flat tonic water was poured from a Vodka bottle in direct sight of the participants. The glasses in which the drinks were served were rimmed with vodka and the bar was wiped down with 190 proof alcohol to provide olfactory cues. In addition, 190-proof alcohol was splashed onto the top of each placebo drink using a plastic lime. Finally, participants in both the alcohol and placebo group received printed output from a breathalyzer indicating that their BAC was .04 g%. These procedures are consistent with those outlined by Rohsenow and Marlatt (1981) and have been used successfully in our lab in previous studies. Research assistants serving the drinks were blind to condition. A 15-minute absorption period followed the third drink, at which time participants completed the craving item. It was reported previously that those administered placebo reported significantly lower estimates of their alcohol consumption, lower subjective “high” and “intoxication” than those administered alcohol. The magnitude of these differences compared well with other recent studies and the authors concluded that the placebo manipulation was credible (Corbin, Gearhardt, & Fromme, 2008).

As a cover story for the ad libitum access period, participants were informed that they would have 20 minutes to prepare a five minute speech about what they liked and disliked about their bodies or what made them a desirable dating partner. This is a standard social stressor that has been used successfully in prior alcohol administration research (Sayette, Breslin, Wilson, & Rosenblum, 1994). During the 20 minute preparation period, participants were given free access to alcoholic and non-alcoholic beverages. The amount of alcohol consumed by each participant was recorded by an objective observer, and no participant was allowed to exceed a BAC of .12 g%. At baseline and during this period, the Profile of Mood States (POMS; Gabrielli, Nagoshi, Rhea, & Wilson, 1991) was administered. Previous analyses found that change scores on the POMS between baseline and introduction of the speech manipulation had no impact on ad libitum consumption in the placebo condition (Corbin et al., 2008). Thus, POMS change scores were not included in the current analyses. At the end of the session,

participants were debriefed, held until their BAC was less than .02 g%, paid \$50 and taken home.

3. Results

3.1. Descriptive statistics, bivariate correlations and initial regression analysis

Analyses were conducted using SPSS version 15.0 for Windows (SPSS Inc., 2006). All continuous variables were examined for outliers and normality and transformations were used as needed to correct skew. Descriptive statistics by beverage condition and the overall sample are provided in Table 1. A series of 2×2 ANOVAs were used to test differences in ad libitum consumption, typical weekly alcohol consumption, craving and the personality variables by beverage condition and gender. There were no main effects of beverage condition, suggesting comparable levels across groups. There was a significant gender main effect for ad libitum drinks consumed (male $M = 2.03$, $SD = 1.15$, female $M = 1.31$, $SD = 1.11$), $F(1, 162) = 17.00$, $p < .001$. Males ($M = 18.03$, $SD = 9.71$) also reported higher typical weekly alcohol consumption relative to females ($M = 10.84$, $SD = 7.35$), $F(1, 168) = 33.44$, $p < .001$. Males also ($M = 0.21$, $SD = 0.71$) scored higher than females ($M = -0.21$, $SD = 0.81$) on trait disinhibition, $F(1, 167) = 12.49$, $p = .001$, and lower on harm avoidance/inhibition (male $M = -0.33$, $SD = 0.79$, female $M = 0.35$, $SD = 0.87$), $F(1, 164) = 26.79$, $p < .001$.

Hierarchical multiple regression analyses were used to test the primary study hypotheses regarding craving and personality traits as predictors of ad libitum alcohol consumption. Bivariate correlations among the variables included in the regression models are provided in Table 2, both by beverage condition and in the overall sample. Initial regressions tested for a beverage condition by craving interaction in the prediction of ad libitum consumption. To create the interaction term, craving scores were first centered and then multiplied by “1” for participants randomized to the placebo administration condition and by “2” for participants randomized to alcohol administration. Typical weekly alcohol use and gender were included in all regression models as men and heavier drinkers at baseline tended to consume more drinks ad libitum. Separate follow-up analyses were planned in order to test for possible mediation of associations between personality factors and ad libitum consumption by craving.

In the initial regression analysis predicting ad libitum consumption from beverage condition, craving, and their interaction, the hypothesized interaction between beverage condition and craving was significant (Table 3). That craving predicted ad libitum consumption in the placebo but not in the alcohol administration condition was verified by a significant correlation between craving and ad libitum consumption in the placebo, but not in the alcohol condition (Table 2).

3.2. Mediation analyses

In the follow-up analyses, Baron and Kenny's (1986) procedures were used to test the hypothesis that craving would mediate associations between personality traits and ad libitum consumption. Consistent with Baron and Kenny's (1986) approach, the following three findings must be demonstrated: 1) the independent variable (IV—personality trait) predicts the dependent variable (DV—ad libitum consumption); 2) the IV predicts the mediator variable (craving) and 3) the mediator predicts the DV holding the IV constant. Our goal was to demonstrate mediation holding constant gender and baseline alcohol use. We again made use of hierarchical multiple regression analysis. First, the personality traits were assessed as predictors of craving after the entry of gender and baseline alcohol use at step 1 (to satisfy criterion 2). The personality traits were then included in a separate regression model to predict ad libitum consumption after entry of gender and baseline alcohol use at step 1 and before entry of craving at step 3 (to satisfy criteria 1 and 3). Given a significant craving $\times$ beverage condition

interaction showing that craving was significantly correlated with ad libitum consumption in the placebo condition only, mediator analyses were restricted to this condition.

In an initial regression, trait disinhibition significantly predicted craving, $B = 10.70$, $SE B = 4.42$, $\beta = 0.29$, $p = .018$, but harm avoidance/inhibition did not, $B = -2.84$, $SE B = 3.87$, $\beta = -0.09$, $p = .465$. Given the latter finding, the possibility of mediation involving harm avoidance/inhibition was not considered further. In a second regression (Table 4), trait disinhibition predicted ad libitum consumption at step 2 and craving (step 3) predicted ad libitum consumption with trait disinhibition and the other variables already entered into the model. Trait disinhibition declined in significance, but remained a significant predictor of ad libitum consumption with craving added to the model. Thus all three criteria were satisfied, suggesting partial mediation, which was verified with a Sobel test ($z = 1.93$, $p = .053$), showing a marginally significant indirect path.

3.3. Confirmatory Multi-level Models

Due to the nested structure of the data (participants nested within groups), all analyses were replicated using multilevel models in HLM 6.06 (Raudenbush, et al. 2004). All statistically significant results remained significant with the exception of the effect of trait disinhibition on ad-lib consumption when craving was included in the model, $p = .146$. In addition, the indirect effect of trait disinhibition on ad-lib consumption operating through craving reached statistical significance, Sobel $z = 2.15$, $p = .032$. Only one additional significant effect emerged, with participants in the placebo condition reporting lower levels of harm avoidance/inhibition relative to participants in the alcohol condition, $t = 2.31$, $p = .025$.

4. Discussion

Consistent with hypotheses, craving reported after placebo administration predicted subsequent ad libitum alcohol consumption, whereas craving following alcohol administration did not. These findings support Tiffany's cognitive processing model (1990), in which craving is a conscious, subjective experience occurring when access to alcohol is somehow blocked. While the placebo manipulation in this study was considered to be credible, participants administered placebo tended to report lower estimates of their alcohol consumption and less subjective stimulation than those administered alcohol (Corbin et al., 2008). These findings are comparable to other studies in which placebo participants reported weaker alcohol-related effects (Maisto et al., 2002; Marczinski & Fillmore, 2005). The dampened effects with placebo support the notion of placebo administration constituting a partial "blocking" of access to alcohol.

Contrary to our prediction, participants in the alcohol condition reported similar levels of craving to those in the placebo condition. The comparable levels of craving may be a result of well-documented priming effects of alcohol (see de Wit, 2002 for a review). Thus, craving reported following an alcohol dose may be reflective of reinforcing alcohol effects (e.g., stimulation). Given that access to alcohol was not blocked for those in the alcohol administration condition, craving would not be relevant as an elicitor of subsequent alcohol use in Tiffany's model. In fact, craving following alcohol administration did not predict subsequent ad libitum alcohol consumption within the alcohol condition of this sample (Corbin et al., 2008), whereas the experience of subjective alcohol effects (e.g. stimulation) did predict ad-lib drinking.

Personality traits were also correlated with ad libitum consumption. Trait disinhibition had a positive correlation with ad libitum consumption in the placebo condition while harm avoidance/inhibition had a negative correlation. Partial mediation of the relation between trait disinhibition and ad libitum consumption by craving provides some support for the notion of

obsessive craving in the placebo condition (Verheul et al., 1999). It was not surprising that trait disinhibition retained a direct effect in predicting ad libitum consumption given the strong evidence for relationships between trait disinhibition and alcohol use (Justus et al., 2000; Patock-Peckham & Morgan-Lopez, 2006). The present findings offered no support for relief craving in this sample. Baer (2002) suggested that negative affect drinking is not prevalent in undergraduates, thus relief craving may not be common among social drinking young adults.

There were several limitations to this study. First, the study lacked a condition with no expectation of alcohol consumption. An alcohol administration study with random assignment to no alcohol, placebo, or alcohol administration conditions would allow for assessment of the effects of the full range of alcohol blocking on craving ratings, ad libitum consumption and their association. Inclusion of the speech manipulation before the initiation of ad libitum consumption potentially limits generalizability. Change in mood reported by participants following introduction of the speech, however, did not predict ad libitum consumption (Corbin et al., 2008). Also, as this study involved only drinkers ages 21-30, these findings may not apply to older drinkers. Finally, the present study must be considered a limited test of the three-pathway model of craving. In the Verheul et al. (1999) model, the type of craving experienced could be due to personality, biochemistry or some combination of the two, yet we were only able to account for personality. In addition, the experience of craving itself differs in each of the pathways, according to Verheul et al., but the single item measure we used did not permit assessment of varying experiences of craving.

Despite these limitations, the present findings have important implications. Our findings suggest that Tiffany's (1990) cognitive processing model of craving may apply to heavy-to-moderate social drinkers. Thus, in the presence of alcohol-related cues, frequent social drinkers may experience craving when their access to alcohol is partially blocked. The finding that trait disinhibition predicted ad libitum consumption and the partial mediation of this association by craving offer empirical verification for the notion of obsessive craving (Verheul et al., 1999). More broadly, these findings provide further evidence for the impact of individual differences on drinking behavior and suggest that craving may be one mechanism underlying these associations.

Acknowledgments

This research has been supported by grants from the Texas Commission of Alcohol and Drug Abuse (517-9-8444), the National Institutes of Health (NIH) (T32-AA-07471; RO1-AA-11683) and the Co-Operative Society at The University of Texas at Austin. The preparation of this manuscript was also supported by NIH grants T32-DA-007238 and RO1-AA-016621. The authors extend their gratitude to Youngsuk Kim, M.A., Bryan Hartzler, Ph.D., Marc Kruse, M.A., Jason Roth, and a number of dedicated undergraduate research assistants.

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Table 1

Descriptive statistics by beverage condition and overall

Variable	Alcohol		Placebo		Overall	
	Mean	SD	Mean	SD	Mean	SD
Ad libitum drinks consumed	1.65	0.95	1.69	1.39	1.67	1.18
Craving (out of 100)	56.72	25.76	49.45	28.09	53.21	27.08
Typical weekly alcohol consumption	14.79	9.36	13.89	9.23	14.36	9.29
Trait disinhibition (standardized)	0.05	0.84	-0.06	0.72	0	0.79
Harm avoidance/inhibition (standardized)	0.13	0.91	-0.11	0.87	0.01	0.90

Note. Ad libitum drinks consumed was adjusted to account for drinks ordered that participants were not allowed to consume because they reached maximum BAC. Typical weekly alcohol consumption was log transformed for the purposes of analysis. There were no significant main effects of beverage condition.

Table 2

Ad libitum consumption and craving correlated with other predictor variables within each beverage condition and overall

Variable	Alcohol		Placebo		Overall	
	ad lib consumption	craving	ad lib consumption	craving	ad lib consumption	craving
Craving	.19	---	.42***	---	.32***	---
Typical weekly alcohol consumption	.26*	.29**	.19	.24*	.21**	.27***
Trait disinhibition factor	.14	.10	.40***	.33**	.27***	.21**
Harm avoidance/inhibition factor	-.09	.09	-.26*	-.22	-.18*	-.04

*
 $p \leq .05$,

**
 $p \leq .01$,

 $p \leq .001$

Table 3
Summary of a hierarchical multiple regression analysis predicting ad libitum consumption in the entire sample

Variable	First Entry into Model			Final Model		
	B	SE	β	B	SE	β
Step 1 ($R^2 = .00$)						
Beverage (placebo = 1, alcohol = 2)	-0.02	0.19	-0.01	-0.15	0.17	-0.06
Step 2 ($\Delta R^2 = .10^{***}$)						
Gender (female = 0, male = 1)	0.60	0.19	0.25**	0.57	0.19	0.24**
Typical weekly alcohol consumption	0.42	0.31	0.11	0.19	0.30	0.05
Step 3 ($\Delta R^2 = .07^{***}$)						
Craving	0.01	0.00	0.28***	0.04	0.01	0.81***
Step 4 ($\Delta R^2 = .03^*$)						
Beverage $\times$ craving interaction	n/a			-0.02	0.01	-0.56*

Note. Ad libitum drinks consumed was adjusted to account for drinks ordered that participants were not allowed to consume because they reached maximum BAC. Typical weekly alcohol consumption was log transformed for the purposes of analysis.

* $p \leq .05$,
** $p \leq .01$,
*** $p \leq .001$

Table 4
Summary of hierarchical multiple regression analysis predicting ad libitum consumption following placebo

Variable	First Entry into Model			Final Model		
	B	SE B	β	B	SE B	β
Step 1 ($R^2 = .09^*$)						
Gender (female = 0, male = 1)	0.82	0.32	0.30 [*]	0.56	0.30	0.21
Typical weekly alcohol consumption	-0.02	0.53	0.00	-0.42	0.48	-0.10
Step 2 ($\Delta R^2 = .13^{**}$)						
Trait disinhibition	0.63	0.21	0.34 ^{**}	0.46	0.21	0.25 [*]
Harm avoidance/inhibition	-0.15	0.18	-0.10	-0.11	0.17	-0.07
Step 3 ($\Delta R^2 = .09^{**}$)						
Craving following placebo		n/a		0.02	0.01	0.32 ^{**}

Note. Ad libitum drinks consumed was adjusted to account for drinks ordered that participants were not allowed to consume because they reached maximum BAC. Typical weekly alcohol consumption was log transformed for the purposes of analysis.

^{*} $p \leq .05$,
^{**} $p \leq .01$,
^{***} $p \leq .001$