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Mindfulness Buffers the Effects of Cue-Induced Craving on Alcohol Demand In College Drinkers

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Abstract

Alcohol consumption among young adult college students represents a significant public health problem. The presence of alcohol-related cues in drinkers' environments can trigger powerful alcohol cravings, which may influence drinking outcomes. Less is known about how this cue-induced craving influences behavioral economic demand for alcohol. In addition, research has suggested that trait mindfulness may be an important buffer of the effects of internal states of craving on drinking decisions. Based on this literature, we hypothesized that cue-induced cravings would be associated with increased alcohol demand, an effect that would be attenuated among drinkers who have higher levels of mindfulness. Young adult college student drinkers ($n=69$) completed a laboratory-based cue-induced craving assessment, a self-report assessment of trait mindfulness, and an alcohol purchase task. Findings revealed that cue-induced craving was related to higher alcohol demand. Consistent with the study hypothesis, acceptance, a component of mindfulness, buffered the effects of cue-induced craving on alcohol demand. Results raise the possibility that mindfulness-based interventions may be useful in helping disrupt the link between internal states of craving and drinking decisions in young adult college student drinkers.

Keywords

Mindfulness; Cue; Craving; Alcohol Demand

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Author Disclosures

All authors contributed to conceptualization of the research, contributed to the writing of the manuscript and have approved the final version.

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1. Introduction

College student drinking is a significant issue on campuses across the nation (Epler et al., 2009). The National Survey on Drug Use and Health (NSDUH) (2014) found that among full-time college students, approximately 59% were regular drinkers, 39% were binge drinkers, and 13% were heavy drinkers. Hingson, Heeren, and Winter (2005) report numerous negative consequences associated with college drinking, including poorer school performance, higher rates of sexual assault, unintentional injuries, and development of alcohol use disorders (AUDs).

One major factor involved in decisions to consume alcohol is the presence of environmental triggers, or cues, that induce craving. Both clinical reports and empirical evidence have demonstrated that exposure to such cues can induce significant craving reactions (Carter and Tiffany, 1999). Research linking this cue-induced craving to drinking outcomes, however, has yielded mixed results, with some studies demonstrating that cue-induced cravings are associated with increased drinking (e.g., Papachristou et al., 2014), while other studies fail to identify such effects (e.g., Witteman et al. (2015)).

One reason for these equivocal findings may be a focus on overly broad drinking outcomes (e.g., total number of drinks consumed) without sufficient consideration of mechanisms involved in the process of drinking decisions. Recent behavioral economic theories have highlighted the importance of better characterizing the role of “demand” for alcohol in informing drinking decisions (Bickel et al., 2016). Consistent with this possibility, several studies have demonstrated that the magnitude of cue-induced craving, was significantly related to increased alcohol demand using hypothetical alcohol purchase tasks (Amlung and MacKillop, 2014, Amlung et al., 2012). Such tasks provide a more proximal measure of drinking decisions that may be more sensitive to the effects of cue-induced cravings.

Other researchers have found that effects of cue-induced craving on drinking variables may be context- or population-specific. For example, Van Dyke and Fillmore (2015) found that the link between cue reactivity and increased consumption was only evident in heavier drinkers. Courtney et al. (2015) found that numerous contextual factors moderated the relationship between cues and actual drinking. In another study, Erblich and Michalowski (2015) found that among impulsive individuals who are poor at regulating responses to internal states, the relationship between cue-induced craving and tobacco use was particularly strong.

These results raise the intriguing possibility that effects of cue-induced cravings may be dampened in drinkers who are particularly skilled at managing their responses to internal states. Trait mindfulness is one construct that may capture this ability. Mindfulness has been characterized by present-moment awareness and acceptance of internal cues (Cardaciotto et al., 2008), and has been employed as an approach for increasing awareness and responding skillfully to mental processes and experiences that contribute to emotional distress and maladaptive behavior (Bishop et al., 2004). Along these lines, mindfulness has been postulated as a potentially useful tool to reduce alcohol use (Fernandez et al., 2010, Shorey et al., 2013, Smith et al., 2011). To date, there are only limited data on the interplay between

mindfulness, cue-induced craving, and drinking outcomes. In one study, Karyadi and Cyders (2015) found that levels of cue-induced craving mediated effects of mindfulness on problem drinking. To date, however, the possibility that mindfulness may buffer the effects of cue-induced alcohol craving on poor drinking decisions has not been examined. In this study, we hypothesized that: 1) higher cue-induced cravings would be related to increased alcohol demand, 2) higher levels of trait mindfulness would be related to decreased alcohol demand, and 3) the relationship between cue-induced craving and alcohol demand would be attenuated among drinkers with higher levels of trait mindfulness.

2. Material and Methods

2.1. Participants

Young adult drinkers ($n=69$) were recruited by advertisement from an urban university campus. Fifty-two percent of participants ($n=36$) were women and 48% ($n=33$) were men. The mean age of the sample was 21.4 years ($SD=2.2$). Twenty-eight percent of participants reported Caucasian ethnicity, 10% reported African American ethnicity, 25% reported Hispanic ethnicity, 30% reported Asian ethnicity, and 7% reported other ethnicities. In order to be eligible for the study, participants were required to be aged 18–25, with a typical drinking pattern of at least three alcoholic beverages per week. To reduce sources of heterogeneity, participants were excluded if they reported: 1) current alcohol dependence, 2) current other drug use (other than nicotine), or 3) a history of hospitalization for major mental illness. Finally, participants were excluded if they tested positive on a urine toxicology screen for illicit drug use.

2.2. Procedures

All participants provided written informed consent prior to participating in the study. After completing the consent process, participants completed questionnaires and a urine toxicology screen to confirm eligibility, as well as measures of mindfulness and alcohol demand (see below). Next, they participated in a classic in-vivo alcohol cue-exposure session (Monti et al., 1987). Briefly, participants were presented with two cues in counterbalanced order: 1) an alcohol cue, and 2) a neutral cue. For the alcohol cue, an experimenter poured the participant's preferred beverage into a glass and handed the glass to the participant, who was then instructed to hold the glass and periodically sniff the beverage, for a total of 90 seconds. The participant was instructed not to consume the beverage. For the neutral cue, an experimenter poured a glass of water in front of the participant, who then followed the same directions as during the alcohol cue exposure. Craving for alcohol was assessed by self-report immediately before and after each of the exposures. The cue-exposures were separated by a 90-second rest period, during which time participants viewed a nature video that has been shown to help participants 'recover' to baseline following experimental challenges (Piferi et al., 2000). Following the procedures, participants were given a small honorarium (\$30) for their time.

2.3. Measures

2.3.1. Background Variables—Participants completed a questionnaire assessing demographic information, including age, gender, education, income, race/ethnicity, and a

timeline follow back measure of past 90-day drinking habits (Sobell et al., 1979). In addition, they completed the AUDIT, a brief screening measure of alcohol problems (Saunders et al., 1993).

2.3.2. Alcohol Craving—Participants completed a 5-item, 0–100 alcohol craving questionnaire immediately before and after each of the in-vivo exposures. This questionnaire has been used in our previous work (e.g., Erblich et al. (2009)) and evidenced excellent internal consistency (Cronbach's alpha ranged from 0.92–.096) at all four administrations in this study.

2.3.2. Mindfulness—To measure mindfulness, participants completed the Philadelphia Mindfulness Scale (PHLMS; Cardaciotto et al., 2008). The PHLMS is based on a bi-dimensional model of mindfulness (Bishop et al., 2004) that assesses two distinct components of the construct: awareness and acceptance. Awareness involves the self-regulation of attention to the present moment, while acceptance involves the willingness to experience momentary challenges and act upon them in a non-impulsive, non-judgmental fashion. In the current study, Cronbach's alpha for awareness was 0.76, and for acceptance, 0.90.

2.3.3. Alcohol Purchase Task—To measure demand for alcohol, participants completed the Alcohol Purchase Task (APT; Murphy & MacKillop, 2006), a behavioral economic measure of demand for alcohol. The APT asks participants to respond to particular drinking situations, indicating how many standard-sized drinks they would consume at different price points (from \$0 to \$20). The APT generates several behavioral measures, including (1) intensity of demand (i.e. alcohol consumption when drinks are free), (2) breakpoint (i.e., the first price at which consumption is zero), (3) elasticity (i.e., sensitivity to increased price), (4) $O_{\max}$ (i.e., maximum alcohol expenditure), and (5) $P_{\max}$ (i.e., price at maximum alcohol expenditure). The APT has been shown to have excellent psychometric properties (Murphy et al., 2009; Murphy & MacKillop, 2006)

3. Results

3.1. Background Measures

Participants reported consuming an average of 3.3 ($SD=1.7$) drinks per drinking episode, over the past 90 days, and 22.6 drinking episodes in total ($SD=20.7$). Mean AUDIT score was 10.3 ($SD=4.3$), with a score of 13 or more in women, and 15 or more in men, indicating possible problem drinking (Saunders et al., 1993). Participants also reported 6.6 episodes of binge drinking (5 drinks per episode [males]; 4 drinks per episode [females]) over the past 90 days.

3.2. Cue-induced Alcohol Craving

To confirm that alcohol cues elicited craving, we conducted a Cue (Neutral, Alcohol) $\times$ Time (Pre-Stimulus, Post-stimulus) repeated measures ANOVA. Consistent with previous work demonstrating cue-reactivity effects e.g., (Carter and Tiffany, 1999), participants exhibited significant increases in craving following exposure to alcohol cues, but not following

exposure to neutral cues (Figure 1); $F(1,67)=33.13$, $p < 0.001$, $\eta^2=0.33$. Mean craving prior to exposure to the alcohol cue was 11.7 (SE=2.3), compared to 25.6 (SE=3.4) following the exposure. On the other hand, the mean self-reported craving score before the neutral exposure was 11.8 (SE=2.3), and 10.3 (SE=2.1) and after the exposure.

3.3. Cue-Induced Craving and Alcohol Demand

Next, we tested the possibility that cue-induced alcohol cravings were related to elevated demand. To that end, we created a cue-induced-craving predictor variable by calculating a residualized change score for the alcohol cue from pre- to post-exposure, controlling for the craving scores in response to the neutral cue. This alcohol cue-induced craving index was then entered as a predictor, first in a multivariate ANOVA of all 5 APT indices (intensity, elasticity, breakpoint, $P_{\max}$, and $P_{\max}$), followed by individual exploratory analyses of each APT index separately. Finally, because drinking habits have been shown to be strongly predictive of alcohol demand (Murphy et al., 2015), we included drinking variables and AUDIT scores as covariates. Multivariate analysis failed to identify a significant effect of cue-induced craving on alcohol demand; $F(5,59)=1.22$, $p = 0.31$. Interestingly, following univariate regressions revealed that elevated alcohol cue-induced craving was related to higher demand for alcohol as measured by APT intensity, $F(1,62)=8.11$, $b=0.093$, $p < 0.006$, $\eta^2=0.12$. Effects were comparable with or without the inclusion of covariates. There were no univariate effects of cue-induced craving on the other APT indices ($ps > 0.2$).

3.4. Mindfulness and Alcohol Demand

We entered both the awareness and acceptance scales of the PHLMS as predictors of alcohol demand in a multivariate analysis, controlling for drinking variables. The awareness subscale yielded only a marginally significant effect; $F(5,59)=2.02$; $p=0.089$, $\eta^2=0.15$. Follow-up univariate analyses indicated that higher scores on the awareness subscale were marginally related to increased $P_{\max}$, $F(1,64)=3.04$, $b=0.232$, $p < 0.086$, $\eta^2=0.04$. Univariate effects on other APT indices were not significant ($ps > 0.15$). Similarly, there were no significant multivariate or univariate effects of the acceptance subscale on APT indices ($ps > 0.15$).

To test the possibility that mindfulness moderated effects of cue-induced craving on alcohol demand, we conducted a multivariate analysis, including cue-induced craving, mindfulness indices and their interactions as predictors of alcohol demand. Interestingly, we found a significant interaction between cue-induced craving and acceptance on demand; $F(5,59) = 5.61$, $p < 0.0001$, $\eta^2=0.36$. Follow-up univariate analyses revealed that a significant acceptance $\times$ cue-induced craving interaction effect on APT breakpoint, $F(1,65)=2.20$, $p < 0.031$, $\eta^2=0.07$. In addition, the interaction was marginally associated with APT intensity, $F(1,63)=1.72$, $p < 0.090$, $\eta^2=0.04$, and $P_{\max}$; $F(1,65)=1.69$, $p < 0.096$, $\eta^2=0.04$. To further interrogate the significant interaction, we conducted a simple slopes analysis, following the recommendations of Aiken and West (1991). To that end, we calculated slopes for the effect of cue-induced craving on APT breakpoint for low (one *SD* below the mean), medium (mean), and high (one *SD* above the mean) levels of PHLMS acceptance. As depicted in Figure 2, findings revealed that acceptance buffered the effects of cue-induced craving on APT breakpoint; slopes for the relationship between cue-induced craving and breakpoint were -0.06 , -0.1 , and $+0.03$ for high, medium, and low levels of acceptance, respectively.

Similar trends were observed for the marginally significant effects on intensity and $P_{\max}$. All effects were comparable with or without inclusion of drinking variables. There were no significant multivariate or univariate effects of the awareness $\times$ cue-induced craving interaction term on APT indices ($ps > 0.15$).

4. Discussion

Consistent with previous research (Amlung and MacKillop, 2014), we found that cue-induced craving was associated with alcohol demand. Perhaps most interestingly, though, we found that higher levels of trait mindfulness attenuated this relationship. In particular, cue-induced craving was related to higher APT breakpoint among young adult drinkers who scored low on trait levels of acceptance. Although overall effects of cue-induced craving on breakpoint were observed in previous work (Amlung and MacKillop, 2014), the present results suggest a potentially important buffering effect of mindfulness.

It should be noted that in the present study, neither the acceptance nor the awareness index of mindfulness was significantly related to alcohol demand as a main effect. This finding is broadly consistent with notion that, rather than directly impacting outcomes, trait mindfulness exerts its influence by modulating the effects of experiencing environmental challenges. The results continue to highlight the important interplay between situational (e.g., exposure to alcohol cues) and dispositional (e.g., trait mindfulness) factors in better understanding drinking decisions and demand for alcohol.

The findings underscore the role that acceptance can play in decreasing alcohol demand in those who experience cue-induced cravings, suggesting that interventions aimed to increase acceptance may improve drinkers' ability to manage urges to drink that stem from triggers in the environment. Indeed, emerging work demonstrates that trait mindfulness can play an important role in managing drinking behavior, especially among young adult college students (Brett et al., 2017), and mindfulness interventions can buffer the effects of craving on substance use (Enkema and Bowen, 2017). Interestingly, the awareness index of the PHLMS was not a significant moderator. This is perhaps consistent with recent findings that acceptance, but not awareness, may be the key component associated with the salubrious effects of mindfulness (Klein et al., 2015).

Strengths of the study include the use of an experimental model to elicit cravings, and the use of behavioral economic indices of alcohol demand/drinking decisions. Although the APT asks about theoretical drinking and spending, studies have found the measure to be highly correspondent to actual behavior (Amlung et al., 2012). Limitations include a somewhat modest sample size and the lack of experimental manipulation of mindfulness. In addition, the cross-sectional nature of the study did not permit the evaluation of possible acute effects of cue-induced craving and mindfulness on alcohol demand. Future research employing a within-subjects design, assessing state changes in demand during craving would be an important next step. In addition, studies of the efficacy of mindfulness interventions on mitigating the effects of craving on drinking decisions in larger samples may be warranted. Indeed, one recent study found that brief, scalable mindfulness-based interventions can be useful in moderating drinking when encountering alcohol cues (Kamboj

et al., 2017). Laboratory models of craving during such interventions may provide a glimpse into the mechanisms underlying treatment effects, potentially leading to improved preventive interventions for young adult drinkers. Indeed, mindfulness interventions specifically focused on acceptance of thoughts may prove to be a useful therapeutic goal for drinkers working on managing alcohol cravings in their daily environments.

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HIGHLIGHTS

- Cravings for alcohol after exposure to alcohol cue predict increased alcohol demand
- These effects were buffered by high levels of mindfulness.
- Results support the use of mindfulness as a method to reduce poor drinking decisions when faced with alcohol cues and their attendant cravings.

Figure 1. Regression lines depicting effects of cue-induced craving on APT breakpoint (price at which consumption = 0). Effects are moderated by PHLMS Acceptance.

Table 1

Study Variables [Mean (SD)]

Drinking Variables	
AUDIT	10.3 (4.3)
Drinking Episodes (past 90 days)	22.6 (20.7)
Drinks Per Drinking Episode (past 90 days)	3.3 (1.7)
Binge Episodes (past 90 days)	6.6 (8.2)
Cue-Induced Craving	
Alcohol Cue (Post minus Pre)	14.0 (18.0)
Neutral Cue (Post minus Pre)	-1.5 (7.9)
Mindfulness (PHLMS)	
Acceptance	27.6 (7.8)
Awareness	36.5 (5.5)
Alcohol Demand (APT)	
Intensity	9.9 (5.5)
Elasticity	0.007 (0.003)
Breakpoint	14.6 (4.4)
$Q_{\max}$	23.8 (11.3)
$P_{\max}$	8.2 (5.6)