# Gender and Impulsivity: Effects on Cue-Induced Alcohol Craving

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**Background:** Numerous studies have demonstrated that trait impulsivity is linked to increased risk of developing alcohol-use disorders and other substance abuse. Impulsivity has also been shown in some studies to potentiate cue-induced drug cravings. Despite considerable evidence of gender differences in impulsivity and drug craving among individuals suffering from alcohol dependence and other drug use, little research has focused on these processes in healthy young men and women who may be at risk for developing alcohol-use disorders. The objective of this study was to investigate the relationship between impulsivity and cue-induced craving, as well as possible gender differences in these effects among healthy young adults.

**Methods:** To that end, female ($n$ = 22) and male ($n$ = 14) social drinkers aged 18 to 25, recruited from an urban university campus, completed the Barratt Impulsiveness Scale and reported their alcohol cravings immediately before and after laboratory exposure to alcohol cues.

**Results:** Findings indicated that exposure to cues elicited increased alcohol cravings, but these effects did not differ by gender. Interestingly, a significant interaction of impulsivity and gender revealed that impulsivity predicted significantly higher cue-induced cravings in women, but not men.

**Conclusions:** Findings underscore the importance of better understanding the interaction of situational factors (e.g., exposure to alcohol cues) and dispositional factors (e.g., impulsivity) as potential contributors to drinking motivation. Future prospective research is needed to identify gender-specific risk factors for the development of problem drinking.

**Key Words:** Cue-Induced Craving, Impulsivity, Gender, Young Adult.

ALCOHOL-RELATED PROBLEMS continue to present a significant public health concern. Drinking among young adult college students, in particular, continues at alarming rates, with approximately 60% of American college students reporting past-month alcohol use (SAMHSA, 2014). Despite the fact that men drink more than women (Nolan-Hoeksema, 2004), rates of alcohol use among college-aged women, in particular, have been on the rise (SAMHSA, 2014).

Research over the past decade has demonstrated that trait impulsivity may play a critical role in the genesis and maintenance of drinking behavior in young adults (de Wit, 2009). Impulsivity has been defined variably as a multifaceted trait, characterized by poor inhibitory control, overvaluation of immediate reward, and reduced sensitivity to punishment (Cross et al., 2011). Numerous studies have demonstrated that trait impulsivity is linked to increased risk of developing alcohol-use disorders and other substance abuse (Jentsch and Taylor, 1999; Lejuez et al., 2010; Weafer et al., 2013). For example, in a study of young adult college students, MacKillop and colleagues (2007) found that self-reported trait impulsivity was higher among heavy drinkers. In another study, Chassin and colleagues (2004) found that trait impulsivity prospectively predicted heavy drinking in a sample of adolescents.

Emerging evidence now suggests that although men tend to be more impulsive than women in general (Petry et al., 2002; Stoltenberg et al., 2008; Waldeck and Miller, 1997), the link between impulsivity and problem drinking is particularly strong among women (Weafer and de Wit, 2014). For example, Weafer and colleagues (2015), as well as Nederkoorn and colleagues (2009), found that heavy-drinking women displayed significantly poorer inhibitory control than heavy-drinking men. In a prospective study, Stojek and Fischer (2013) found that impulsivity prospectively predicted symptoms of alcohol dependence in a sample of young adult college-aged women. Despite a considerable body of literature supporting the link between impulsivity and problem drinking, especially in women, the mechanisms underlying this link remain to be elucidated.

One possible explanation comes from a study by Papachristou and colleagues (2012), who found that heavy drinkers with higher levels of impulsivity exhibited stronger craving reactions when exposed to alcohol cues. Indeed,

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craving responses to drug cues have long been thought of as important triggers of drug use (Carter and Tiffany, 1999). This "cue-induced craving" has been modeled reliably in the laboratory across multiple drugs of abuse, including nicotine (Erblich and Bovbjerg, 2004), cocaine (Sinha et al., 2000), and alcohol (Erblich et al., 2009; Willner et al., 1998). Further consistent with a link between impulsivity and cue-induced craving, Doran et al. (2007, 2008), in a series of studies, found that smokers with higher levels of impulsivity exhibited elevated craving reactions in response to laboratory exposures to smoking cues.

The link between impulsivity and cue-induced craving is consistent with classic theoretical conceptualizations of drug use (Arnett and Newman, 2000; Jentsch and Taylor, 1999). As indicated above, impulsive drug users are thought to exhibit poor inhibitory control and overvaluation of reward. Such individuals may be predisposed to focus excessively on rewarding stimuli such as drug cues, and exhibit poor control of their reactions to these cues. Although studies have linked impulsivity to cue-induced craving, the possible effects of gender have largely been ignored. One exception is a recent study by Doran (2014), who found that women reported greater preference for immediate smoking following exposure to smoking cues than men. These findings in a sample of smokers suggest a significant link between craving and impulsivity among women. To our knowledge, however, the link between impulsivity and cue-induced alcohol craving in women has not been examined.

The purpose of the present study was to examine the combined impact of gender and trait impulsivity on cue-induced alcohol craving in young adult social drinkers. Consistent with the previous literature, we hypothesized that trait impulsivity would predict elevated cue-induced alcohol craving. In addition, we predicted that these effects would be particularly pronounced in women.

## MATERIALS AND METHODS

### *Participants*

Adult female ($n$ = 22) and male ($n$ = 14) college student social drinkers were recruited by advertisement from an urban university campus. Qualifying participants for this study were aged 18 to 25 with a typical drinking pattern of at least 3 alcoholic beverages per week. To reduce sources of heterogeneity in the sample, participants were excluded if they reported or screened positive for: (i) current alcohol dependence, (ii) current other drug use (other than nicotine), or (iii) a history of hospitalization for major mental illness.

### *Procedures*

Participants were exposed to 2 imaginal cues in counterbalanced order: (i) a neutral cue, during which participants listened to a script describing someone changing a lightbulb, and (ii) an alcohol cue, during which participants listened to a script describing a drinking situation. To provide a richer cue exposure, the alcohol script was personalized to include references to the participants' preferred alcoholic beverage. Scripts were analogous to those employed by us (Erblich et al., 2009) and others (Maude-Griffin and Tiffany, 1996) in previous work. Research staff read the script to participants for 60 seconds, followed by a 30-second silent period, during which participants were instructed to continue thinking about the script. Craving was assessed immediately before and after each of the exposures, and vividness of imagery was assessed following each of the exposures. The cue exposures were separated by a 90-second rest period, during which time participants viewed a nature video (Piferi et al., 2000).

### *Measures*

*Background Variables.* Participants completed a questionnaire assessing basic demographic information, including age, gender, education, income, race/ethnicity, and drinking habits. In addition, participants completed the Obsessive-Compulsive Drinking Scale (OCDS) (Anton et al., 1995). The OCDS measures general motivation and urge to drink, and served as a measure of problem drinking behavior. The OCDS has been shown to have excellent psychometric properties (Moak et al., 1998).

*Impulsivity.* To measure impulsivity, participants completed the 30-item Barratt Impulsiveness scale (BIS-11) (Patton et al., 1995). The BIS has 3 subscales: Attentional Impulsivity, Motor Impulsivity, and Nonplanning Impulsivity. In addition, each of the 3 BIS subscales comprises 2 "first-order" subscales. The Attentional Impulsivity subscale comprises Attention and Cognitive Instability indices. The Motor Impulsivity subscale comprises Motor Impulsivity and Perseverance indices. Finally, the Nonplanning Impulsivity subscale comprises Self-Control and Cognitive Complexity indices. The BIS has been used extensively and has been shown to predict numerous behavioral, clinical, and substance use outcomes (Stanford and Jones, 2009; Stanford et al., 2009).

*Alcohol Craving.* Participants completed a 5-item, 0 to 100 alcohol craving questionnaire immediately before and after each of the cue 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 0.84 to 0.096) at all 4 administrations. The instrument is an improvement over the use of single-item craving assessments (Kozlowski and Wilkinson, 1987; Kozlowski et al., 1989), and assessed craving using multiple descriptors, including "craving," "urge," "want," and "desire."

*Vividness of Imagery.* After each of the exposures, participants completed a 4-item, face-valid (e.g., "How vivid did your images seem?" or "How real did your images seem to you?") 0 to 25 scale of imagery strength. This instrument has been used in our previous work (Erblich and Bovbjerg, 2004; Erblich et al., 2005), and demonstrated strong internal consistency (Cronbach's alpha ranging from 0.85 to 0.92 for both administrations) in the current sample.

## RESULTS

### *Background Variables*

Sixty-one percent of participants ($n$ = 22) were women and 39% ($n$ = 14) were men. The mean age of the sample was 22.8 years (SD = 1.9). Forty-two percent of participants reported Caucasian ethnicity, 22% reported African American ethnicity, 17% reported Hispanic ethnicity, and 17% reported Asian ethnicity. Participants reported beginning to drink regularly at age 19.2 (SD = 2.2), consuming an average of 3.7 (SD = 1.9) drinks per drinking episode, and 2.8 (SD = 1.2) drinking episodes per week. Mean OCDS score in this non-alcohol-dependent sample of social drinkers was

10.4 (SD = 4.8), well below the mean scores typically reported in clinical samples (e.g., 22.5, reported in Anton et al., 1995) (Table 1).

### *Cue-Induced Alcohol Craving*

Consistent with the literature on alcohol-dependent subjects, participants in this non-alcohol-dependent sample exhibited elevated craving responses to the alcohol imagery. The mean prestimulus craving score was 11.2 (SE = 2.1), compared to a mean poststimulus score of 18.0 (SE = 3.4). In contrast, craving scores before and after exposure to the neutral stimulus were 14.3 (SE = 3.8) and 13.5 (SE = 3.0), respectively. As depicted in Fig. 1, a repeated-measures ANOVA revealed a statistically significant Cue (Neutral, Alcohol) × Time (Prestimulus, Poststimulus) interaction; $F(1, 32) = 4.6$, $p < 0.039$, $\eta^2 = 0.126$. Results were unchanged when including OCDS and vividness in the model as covariates. To rule out possible carryover effects, we compared prestimulus craving scores for the first (mean 15.1 ± 3.7) and second (mean 10.2 ± 2.1) cues (across cue types) and found no significant effects, $t(35) = -1.5$; $p < 0.149$, $d = 0.268$. Finally, to test for order effects, we reran the ANOVA with Order (Neutral first, Alcohol first) as a predictor and found no changes in results.

**Table 1.** Study Variables by Gender

| | Total ($n$ = 36) | Female ($n$ = 22) | Male ($n$ = 14) |
|---|---|---|---|
| Background variables | | | |
| Age | 22.8 (1.9) | 22.6 (1.6) | 23.0 (2.3) |
| Race/Ethnicity | | | |
| African American | 22% | 23% | 21% |
| Asian American | 17% | 18% | 14% |
| Caucasian | 42% | 41% | 43% |
| Hispanic | 17% | 18% | 14% |
| Other | 3% | 0% | 7% |
| Drinking behavior | | | |
| Age of onset | 19.2 (2.2) | 18.9 (2.4) | 19.6 (1.7) |
| Drinks/wk | 2.8 (1.2) | 3.0 (1.3) | 2.4 (1.1) |
| Drinks/episode | 3.7 (1.9) | 3.5 (2.0) | 4.0 (1.8) |
| Obsessive-Compulsive Drinking Scale | 10.4 (4.8) | 11.0 (5.3) | 9.4 (4.0) |
| Barratt Impulsiveness scale total score | 61.4 (13.3) | 61.2 (15.3) | 61.6 (9.8) |
| Attentional impulsivity | 17.1 (5.2) | 16.8 (5.9) | 17.6 (4.0) |
| Attention | 10.5 (3.3) | 10.2 (3.8) | 10.9 (2.5) |
| Cognitive instability | 6.6 (2.2) | 6.6 (2.4) | 6.7 (2.0) |
| Motor instability | 21.6 (5.8) | 22.0 (6.5) | 21.2 (4.4) |
| Motor | 14.5 (4.2) | 14.6 (4.8) | 14.3 (3.4) |
| Perseverance | 7.1 (2.1) | 7.3 (2.5) | 6.9 (1.5) |
| Nonplanning | 22.6 (4.4) | 22.5 (4.5) | 22.8 (4.2) |
| Self-control | 11.9 (3.3) | 11.6 (3.4) | 12.3 (3.0) |
| Cognitive complexity | 10.7 (2.1) | 10.9 (2.0) | 10.4 (2.3) |
| Alcohol craving (0 to 100) | | | |
| Neutral cue exposure | | | |
| Prestimulus | 14.3 (22.1) | 15.4 (26.9) | 12.3 (11.8) |
| Poststimulus | 13.5 (19.0) | 10.5 (17.0) | 17.7 (21.7) |
| Alcohol cue exposure | | | |
| Prestimulus | 11.2 (13.2) | 10.1 (13.4) | 12.7 (13.2) |
| Poststimulus | 18.0 (21.1) | 17.9 (23.5) | 18.1 (17.4) |
| Imagery vividness (0 to 25) | | | |
| Neutral cue exposure | 17.8 (5.2) | 18.3 (4.7) | 17.0 (6.0) |
| Alcohol cue exposure | 18.2 (5.4) | 18.0 (6.3) | 18.5 (3.7) |

Means (SD) and percentages, where applicable, are displayed.

### *Predictors of Cue-Induced Craving*

We next tested the possibility that gender and impulsivity would predict craving responses to the alcohol cues. Results of a mixed-design ANOVA, including gender and BIS scores to the repeated-measures model, failed to identify any significant main effects of gender; $F(1, 32) = 1.1$, $p < 0.309$, $\eta^2 = 0.015$. Similarly, there was no main effect of impulsivity; $F(1, 32) = 2.2$, $p < 0.152$, $\eta^2 = 0.058$. We then added a Gender × Impulsivity interaction term to the model. Interestingly, there was a significant interaction between gender and impulsivity; $F(1, 32) = 7.3$, $p < 0.011$, $\eta^2 = 0.145$. To better characterize this interaction, we performed a simple slopes analysis for each gender, following the recommendations of Aiken and West (1991). To that end, we calculated an "alcohol cue-induced craving" score (post-alcohol-cue craving minus pre-alcohol-cue craving) as the dependent variable, and included pre-alcohol-cue craving and neutral cue-induced craving scores as covariates. This approach yielded baseline-adjusted cue-induced craving scores, and accounts for variability in craving observed at alcohol prestimulus, and during neutral cue exposure (see Table 1). BIS scores were added as the predictor, and the analyses were stratified by gender. As depicted in Fig. 2, the analyses revealed a positive relationship between scores on the BIS and alcohol cue-induced cravings in women ($b = 0.366$, SE = 0.2, $p < 0.024$, $\eta^2 = 0.265$), but not in men, for whom the relationship trended in the opposite direction ($b = -0.560$, SE = 0.561, $p < 0.341$, $\eta^2 = 0.117$).

### *Subscale Analyses of the Relationship Between BIS and Cue-Induced Craving*

To better understand the significant Gender × Impulsivity interaction, we performed separate follow-up analyses of

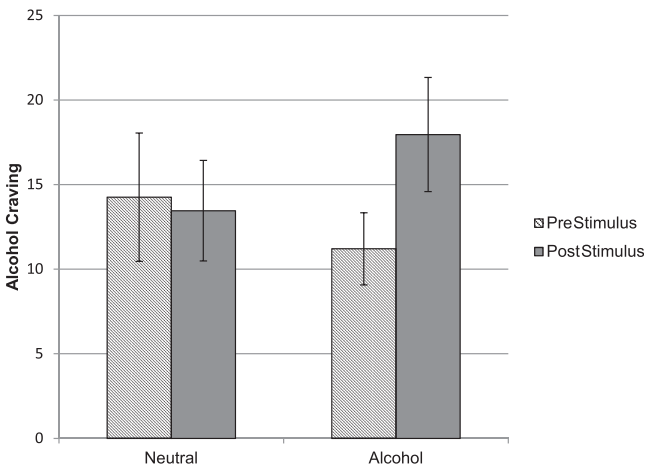


**Fig. 1.** Alcohol craving scores before and after exposure to neutral stimuli and alcohol stimuli. The Cue (Neutral, Alcohol) × Time (Prestimulus, Poststimulus) interaction was significant; $F(1, 32) = 4.6$, $p = 0.039$.

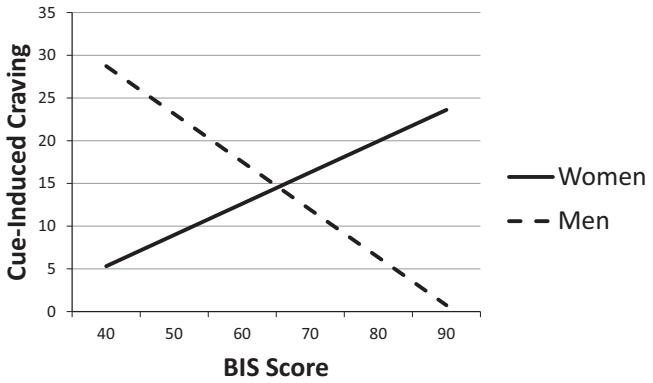


**Fig. 2.** Regression lines depicting relationships between total Barratt Impulsiveness scale impulsivity score and cue-induced craving for men ($p < 0.341$) and women ($p < 0.024$).

the 3 first-order subscales of the BIS: Attentional Impulsivity, Motor Impulsivity, and Nonplanning Impulsivity. Findings revealed a significant Gender × Attentional Impulsivity interaction; $F(1, 32) = 9.9$, $p < 0.004$, $\eta^2 = 0.247$, as well as a significant Gender × Motor Impulsivity interaction; $F(1, 32) = 4.8$, $p < 0.036$, $\eta^2 = 0.128$. The Gender × Nonplanning Impulsivity interaction, however, was not significant; $F(1, 32) = 1.5$, $p < 0.230$, $\eta^2 = 0.025$. These findings suggest that the effects of impulsivity on cue-induced craving in women were specifically driven by attentional and motor impulsivity. Simple slopes analyses revealed a comparable pattern of results to those already depicted in Fig. 2.

Finally, we performed follow-up analyses of the 2 second-order subscales associated with Attentional and Motor Impulsivity. As indicated previously, the BIS Attentional subscale consists of 2 second-order subscales: "Attention" and "Cognitive Instability." The Motor Impulsivity subscale consists of 2 second-order subscales: "Motor" and "Perseverance." Findings revealed that both the Gender × Attention, $F(1, 32) = 7.7$, $p < 0.010$, $\eta^2 = 0.207$, and the Gender × Cognitive Instability, $F(1, 32) = 6.6$, $p < 0.015$, $\eta^2 = 0.190$, interactions were significant. In contrast, second-order subscale analyses of the Motor Impulsivity subscale failed to identify significant effects. Neither the Gender × Perseverance nor the Gender × Motor interaction terms reached significance ($F$'s 3.1 and 3.7, $p$'s < 0.089 and 0.066, $\eta^2$'s = 0.083 and 0.085, respectively).

## DISCUSSION

The objective of this study was to better characterize the role of gender in the relationship between impulsivity and craving for alcohol consumption. In particular, we hypothesized that impulsivity would predict elevations in craving responses to alcohol cues, and that these effects would be particularly strong in women. Consistent with previous research on social drinkers, findings indicated that exposure to alcohol cues elicited increased alcohol cravings. These effects were comparable for men and women. A significant interaction of impulsivity and gender, however, revealed that impulsivity predicted significantly higher cue-induced cravings in women.

These results supported the primary study hypothesis; impulsivity predicted elevated cue-induced cravings among women, but not men. As indicated previously, findings are consistent with emerging research suggesting that impulsivity may play a particularly important role in inhibitory control and reward sensitivity among women (Nederkoorn et al., 2009; Weafer and de Wit, 2014; Weafer et al., 2015). Previous research has suggested that gender differences in impulsivity may be correlated with elevations in circulating estradiol (Colzato et al., 2010; Smith et al., 2014). If so, it would stand to reason that impulsivity-related changes in craving may be phase dependent among premenopausal women. Consistent with this possibility, one recent study (Franklin et al., 2015) reported that premenopausal female smokers in the follicular phase (associated with higher estradiol levels) of their menstrual cycles exhibited heightened responsivity to smoking cues compared with women in luteal phase. Nevertheless, other studies found inconsistent results [see Weinberger and colleagues (2015) for a systematic review]. Additional research is warranted to determine the generalizability of the observed effects across the menstrual cycle, as well as correlates with circulating estradiol.

Another possibility is that women may be more sensitive to the neurotoxic effects of alcohol. As a result of drinking, they may be more likely to exhibit deficits in frontal-executive functioning processing, including deficits in self-regulation and impulsivity (Squeglia et al., 2012). Whether or not such effects, however, even on a mild level, occur in social-drinking women remains unclear.

Although we predicted a main effect of impulsivity on cue-induced craving across genders, this hypothesis was not borne out. Previous research also yielded mixed results. For example, Doran and colleagues (2009) found that only one operational definition of impulsivity, sensation seeking, was related to cue-induced craving. On the other hand, Doran and colleagues (2008) found that impulsivity, as measured by the BIS-11 total score, was related to cardiovascular responses to cues, but not to self-report. It is tempting to speculate that a closer examination of the moderating effects of gender would shed light on the mixed findings with respect to impulsivity and cue-induced craving. Consistent with this possibility, a recent report from Doran (2014) found that, in response to smoking cues, women, but not men, reported increases in preferences for immediate versus delayed smoking. The possibility that social-drinking women may discount delayed alcohol consumption upon encountering alcohol cues warrants further attention.

There are several limitations worth noting in the current study. First, as indicated above, impulsivity is a multifaceted construct with many diverse operational definitions in the literature. Although the BIS-11 assesses several different aspects of impulsivity, other studies have focused on behavioral tasks, such as delay discounting, Go–NoGo tasks, and gambling tasks, to assess impulsivity. It is possible that gen-

der differences are domainspecific. Indeed, initial evidence points to some degree of specificity that warrants future research (Weafer and de Wit, 2014).

In addition, although the study demonstrated an effect of impulsivity on cue-induced craving among women, longitudinal assessments of drinking behavior were lacking. Thus, follow-up studies are needed to connect the current results to actual problem drinking behavior and development of alcohol problems. Finally, the sample size in this study was small, especially in the subset of male social drinkers, for whom effects were not observed. Thus, results should be interpreted with appropriate caution. Future research in larger samples of social drinkers will permit the evaluation of the effects of impulsivity on both craving for alcohol and drinking behavior, in the hopes of identifying gender-specific individual traits that are important for the genesis and maintenance of problem drinking. Despite these limitations, the current study raises the intriguing possibility that among female social drinkers, trait impulsivity may serve to potentiate reactions to external stimuli that trigger urges to drink. As a result, clinical and preventive efforts may profitably focus on the interaction of situational factors (e.g., exposure to alcohol cues) and dispositional factors (e.g., impulsivity) as potential contributors to drinking motivation.

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