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Alcohol Consumption, Craving, and Craving Control Efforts Assessed Daily in the Context of Readiness to Change among Individuals with Alcohol Dependence and PTSD

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Abstract

Research has demonstrated the positive association between alcohol craving and alcohol use and has identified craving as a central component of alcohol use disorders (AUD). Despite potential clinical implications, few studies have examined the relationship between craving and alcohol use in individuals with AUD and common psychiatric comorbidities or explored possible moderators of the craving-alcohol use relationship. The current study used daily monitoring data to: 1) replicate previous findings detecting a positive relationship between craving and alcohol use in individuals with AUD and co-occurring posttraumatic stress disorder (PTSD) and 2) extend these findings by examining the influence of initial change motivation on the craving-use relationship and within-day associations among craving, efforts to control craving, and alcohol consumption. Participants were 84 individuals with alcohol dependence and PTSD enrolled in an intervention study. Generalized estimating equations using pre-treatment baseline daily data revealed significant main effects for craving, craving control, and motivation to change alcohol use. Daily craving was positively related to alcohol use. Greater change motivation and craving control (i.e., efforts to resist craving, avoidance of thoughts and feelings related to craving) were negatively related to alcohol use. A significant interaction was detected between baseline change motivation and daily craving indicating that the association between craving and alcohol use was significantly stronger for those with low baseline change motivation. A significant interaction was also detected between craving control and daily craving, suggesting participants were more likely to consume

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alcohol when experiencing high levels of craving if they reported low levels of craving control. Findings bolster the idea that efforts to prevent or ameliorate craving are critical to treatment success for individuals with AUD and PTSD who are seeking to reduce or quit drinking.

Keywords

alcohol; PTSD; craving; motivation to change

1. Introduction

Alcohol use disorders (AUDs) result in substantial personal and public harm, including losses in workplace productivity, inflated health care costs, and untold damages to personal relationships and overall functioning (Bouchery, Harwood, Sacks, Simon, & Brewer, 2011; Levola & Pitkanen, 2012). Moreover, alcohol-involved conditions and incidents are among the most prominent causes of mortality in the United States, accounting for between 2% and 4.9% of deaths annually (World Health Organization, 2011). AUDs commonly co-occur with Posttraumatic Stress Disorder (PTSD; Blanco et al., 2013) and the combination is associated with worse occupational functioning, poorer physical health, increased health care utilization, poorer treatment response, higher rates of treatment drop-out and earlier relapse (Blanco et al., 2013; Brady et al., 1994; Drapkin et al., 2011; Ouimette, Moose, & Finney, 2000; Read, Brown & Kahler, 2004).

Effective treatments for AUDs, with and without comorbidities such as PTSD, have expanded in recent years (Jung & Namkoong, 2006; Torchella, Nosen, Rostam, & Allen, 2012), yet these disorders remain largely chronic and relapsing, often causing various harms over the course of a lifetime (Heilig, Goldman, Berrettini, & O'Brien, 2011). As such, deepening our understanding of factors that may maintain problem drinking and AUD in the context of co-occurring PTSD is an important goal with both clinical and public health implications.

1.1. Alcohol Craving as a Fundamental Component of Alcohol Dependence

The construct of alcohol craving is frequently portrayed as a fundamental aspect of the former DSM-IV construct of alcohol dependence (American Psychiatric Association, 2000; Anton, 2000; Meyer, 2000) in that it appears to be both characteristic of alcohol dependence and to have a critical role in maintaining dependence. One study using a large community-based sample of drinkers found that craving loads onto the same latent construct as other previously identified aspects of alcohol dependence, and that adding a craving-specific symptom adds significantly to the discriminant validity of the alcohol dependence syndrome (Keyes, Krueger, Grant, & Hasin, 2011). Similarly, in the context of a study on the genetic influences of craving, Agrawal and her colleagues (2013) found that craving was typically an indicator of greater dependence severity. Other researchers have found that craving distinguishes problem drinkers from non-problem drinkers (Grusser, Morsen, & Flor, 2006; Love, James, & Willner, 1998). Craving assessed prior to an alcohol treatment episode has also been associated with treatment outcome (Connolly et al., 2013; Kranzler, Mulgrew, Modesto-Lowe, & Bursleson, 1999), including findings suggesting that higher pre-treatment

alcohol craving predicts earlier relapse (Flannery, Volpicelli, & Pettinati, 1999). Given these findings, it is unsurprising that craving has been added as a criterion for the diagnosis of AUD in DSM-5 (American Psychiatric Association, 2013) and may play a role in discriminating between milder and more severe forms of the disorder.

Craving has also been found to be a common clinical feature among individuals with comorbid AUD and PTSD. For instance, a number of laboratory cue exposure studies have found that both alcohol and trauma cues activate craving in this group (Coffey, et al., 2002, 2010). The linkage of craving to actual alcohol consumption, has, however not been adequately examined. Interestingly, a cue exposure study by Litt and colleagues (2000) failed to find a robust relationship between in lab craving responses to alcohol cues and alcohol use among people with an AUD only. However, Litt and colleagues did find that craving assessed via a daily monitoring protocol was strongly positively associated with post-treatment drinking and heavy drinking days (see also Kavanagh, May, Andrade, 2009).

1.2. Examining the Day-To Day Relationship Between Craving and Consumption

More recent studies involving frequent data collection methodologies (e.g., daily diary, ecological momentary analysis, etc.) have further contributed to our understanding of the relationship between alcohol craving and consumption. Using 26-days of daily diary assessment data to examine the relationship between craving and recovery outcomes in alcohol dependent patients entering residential treatment, Oslin and colleagues (2009) identified three latent class trajectories of high, medium, and low craving. Those in the high craving class relapsed more quickly and endorsed more alcohol-related problems, more severe depression, and worse physical health functioning than those in the low craving class and worse physical health functioning and mental health functioning than the medium craving class. Additional research on craving and the use of substances other than alcohol that involved frequent monitoring protocols has also found that craving strongly predicts use (Buckner, Crosby, Silgado, Wonderlich, & Schmidt, 2012; Chandra, Scharf, & Schiffman, 2011; Preston et al., 2009) and is associated with relapse (Holt, Litt, & Cooney, 2012; Marhe, Waters, van de Wetering, & Franken, 2013).

1.3. Identifying Factors Impacting the Relationship Between Craving and Consumption

1.3.1. Motivation for change—In order to move beyond bivariate relationship between craving and consumption, it will be essential to identify variables that influence this relationship. A potentially important variable to consider in the context of the craving-consumption relationship is motivation to change alcohol use. The degree of motivation to change alcohol use is associated with AUD treatment outcomes such that those who are more motivated at the outset of treatment tend to have better treatment outcomes than those who are not (Adamson, Sellman, & Frampton, 2009; Evern, Cetin, Durkaya, & Dalbudak, 2010; Ray, Hutchison, & Bryan, 2006). Furthermore, Tiffany (1990) suggested that the quality of craving may change depending on the explicit goals of the individual. That is, those individuals who are highly motivated to change their drinking behavior may well experience more craving since alcohol is essentially off-limits to them. However, it is unknown whether motivation to change alcohol use plays a role in tempering the impact of

craving on drinking, such that those with stronger motivation to reduce or quit drinking at the beginning of a treatment episode are less apt to drink when they experience craving.

1.3.2. Responses to craving: avoidance and thought suppression—How an individual responds to craving may also influence the craving-consumption relationship. One possible response to craving is to attempt to avoid thoughts and feelings associated with it (i.e., craving avoidance). Such experiential avoidance has been conceptualized as attempts to either avoid or otherwise control one's internal experiences, including those of cravings (Hayes, 1994; Hayes, Strosahl, & Wilson, 1999). Several investigators have endeavored to evaluate these relationships with heavy drinking or AUD only samples, though typically in laboratory contexts where actual drinking is not assessed. Palfai and his colleagues (1997) showed that heavy drinkers who were instructed to suppress their urges to drink when exposed to alcohol cues more quickly endorsed alcohol-related expectancies than those who did not receive such instruction, suggesting that suppression of alcohol urges may prime access to alcohol-related memories or information. Similarly, Klien (2007) found that abstinent alcohol dependent adults who suppressed alcohol-related thoughts demonstrated greater interference on the alcohol Stroop task compared to those who freely expressed alcohol-related thoughts prior to completing the Stroop task. More recently, Garland and colleagues (2012) found that higher thought suppression was associated with lower confidence that alcohol urges could be resisted among alcohol dependent adults undergoing an alcohol cue exposure protocol (see also Muraven, Collins, & Nienhaus, 2002). However, using aggregate data collected via daily monitoring, Kavanagh et al. (2009) found that when alcohol dependent individuals attempted to not think about drinking they reported longer latency to drinking onset and drank less. Thus, although the literature is somewhat mixed and the direction of effect is not clear, attempts to suppress or avoid craving may moderate the relationship between craving and use.

1.3.3. Responses to craving: resistance—A related, but somewhat different, construct of interest is craving resistance. Here, rather than coping with craving through avoidance or thought suppression, the emphasis is on using more instrumental means to resist the urge to drink. For example, in an effort to not drink in the face of acute cravings or urges someone could engage in intra-personal strategies such as reminding oneself that craving is a temporary state or observable strategies such as attending a self-help meeting. There is a commonsense appeal to the idea that resistance of alcohol craving might be associated with less drinking and research supporting this theory has begun to emerge. In a study of alcohol and nicotine dependent individuals in outpatient treatment, Cooney and colleagues (2007) assessed self-rated ability to resist drinking, which they termed abstinence self-efficacy, along with drinking and urges to drink through a 14-day ecological momentary analysis (EMA) protocol. In this momentary assessment context, abstinence self-efficacy was associated with lower odds of returning to alcohol use. However, the relationship between craving and abstinence self-efficacy was not assessed in this study, and we therefore do not know whether this form of craving resistance impacts the relationship between craving and drinking in alcohol dependent individuals' day-to-day lives.

1.4. The Current Study

The current study utilized daily interactive voice response (IVR) assessments from the pre-treatment baseline period of a larger experimental intervention study of mechanisms of behavior change in individuals with posttraumatic stress disorder (PTSD) and AUD. This work builds on earlier work with these data that demonstrated that PTSD symptomatology was associated with both same day, and to a lesser extent, next day drinking (Simpson, et al., 2014). The goals of the present investigation were twofold. First, we sought to replicate findings from previous frequent monitoring studies examining the relationship between craving and alcohol use in individuals with AUD and co-occurring PTSD. Based on past results in AUD only samples (e.g., Litt et al., 2000), we hypothesized that alcohol craving would be positively associated with alcohol use within each day. Second, in an effort to extend these findings we sought to identify variables that influence the relationship between craving and alcohol use. Consistent with Tiffany's (1990) characterization of craving being especially salient among individuals actively attempting to change their drinking, we expected that the relationship between craving and use would be moderated by degree of change motivation at baseline. Specifically, we hypothesized that, at lower levels of baseline change motivation, craving would be positively related to use, while at high levels of change motivation, craving would be negatively related to use. We also evaluated whether efforts to avoid thoughts and feelings related to craving and/or efforts to resist urges to drink were related to alcohol use, hypothesizing that greater efforts to avoid and/or resist cravings would be associated with less alcohol use.

2. Method

2.1. Participants and Recruitment

Participants were adult civilians and veterans who were recruited for a larger study examining treatments for AUD and PTSD registered at [ClinicalTrials.gov](https://clinicaltrials.gov) (protocol #: masked for review). Participants were recruited through community newspaper advertisements, flyers, and announcements made at a recurring orientation appointment for veterans pursuing addiction treatment at a major Veterans Affairs medical center. Eligible participants indicated (1) a desire to quit or decrease alcohol use, (2) were at least 18 years old, (3) met criteria for alcohol dependence as defined by the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV; American Psychiatric Association, 2000) and reported having used alcohol in the last 2 weeks, (4) met DSM-IV (American Psychiatric Association, 2000) criteria for Posttraumatic Stress Disorder (PTSD), (5) had the capacity to provide informed consent, and (6) had access to a telephone. Eligible participants also (7) denied opioid use or chronic treatment with opioid-containing medications during the past month, (8) were not currently receiving pharmacological treatment for AUD (e.g., disulfiram, naltrexone, etc.), (9) denied acute suicidality/homicidality with intent/plan, and (10) denied current psychosis.

A total of 92 participants met eligibility criteria and were enrolled in the larger study. However, three participants were excluded from the current study because they failed to complete any monitoring days and three additional participants were not included because they completed less than 50% of possible daily IVR assessments during the baseline period.

An additional two participants were dropped from main analyses for failing to provide their marital status. Participants who were excluded from analyses were more likely to be employed fulltime, $\chi^2 = 3.77$, $p = .05$. There were no other differences between those included versus excluded in demographic variables or in baseline drinking (i.e., number of drinking days and total number of standard drinks consumed; p 's $> .05$). The remaining 84 participants ranged in age from 21 to 63, 48.8% were female, and 26.2% were veterans. In addition to meeting criteria for an AUD, 24.4% of participants reported cannabis use during the six weeks prior to baseline, 15.2% reported cocaine use, 5.1% reported opiate use, 3.8% reported sedative use, 1.3% reported amphetamine use, 1.3% reported sedative use, and 1.3% reported other drug use. Participants denied use of hypnotics, hallucinogens, steroids, and inhalants. Additional demographics can be found in Table 1.

2.2. Procedure

2.2.1. Telephone screening—Individuals interested in the study participated in a telephone or in-person brief screening to ascertain basic eligibility criteria. Those who appeared eligible and remained interested in the study were scheduled for an in-person baseline assessment.

2.2.2. Baseline assessment—Participants provided written informed consent, which was considered valid if their breath alcohol level was .00. They then completed several screening interviews and self-report measures, and those who met study eligibility criteria were familiarized with the daily IVR procedure and the accompanying pager system. They were told that IVR calls needed to be placed by noon each day. IVR monitoring commenced the day after the baseline assessment. Participants were paid \$30 for completing these baseline procedures. All study procedures were approved by the [masked for review] Human Subjects Internal Review Board.

2.2.3. Daily monitoring assessment—Ongoing IVR compliance was automatically tracked by the IVR system created and maintained by Database Systems Corp. When participants failed to call in, they were contacted within two working days by research staff to collect the data verbally and to trouble-shoot any difficulties with the IVR system. Participants were compensated \$1 for every day of completed daily monitoring, with an additional \$10 for completing 7 consecutive days of monitoring or an additional \$7 if they only missed one day of daily monitoring during a given week. Participants were recruited for involvement in a larger study, which involved engaging in a baseline period of IVR monitoring prior to presenting to the laboratory again for a brief intervention and other procedures. The IVR assessments completed during this baseline period are the focus of the current study. Although this baseline period was designed to be 7 days, scheduling issues often resulted in this initial monitoring period being either shorter or longer. As such, participants spent a range of 6 to 20 days in this initial phase of monitoring and all available data were used.

2.3. Measures

2.3.1. Mental health diagnoses—Sections pertaining to substance use and psychotic symptoms of the Structured Interview for DSM-IV Axis I Disorders (SCID-1; First, Spitzer,

Gibbon, & Williams, 1995) were used to assess for current substance use-related and psychotic disorders. The SCID-1 is a widely used interview that has sound psychometric properties (First et al., 1995). Additionally, we used the PTSD Symptom Scale-Interview Version (PSS-I; Foa, Riggs, Dancu, & Rothbaum, 1993) to assess current PTSD status using a one-month timeframe. The PSS-I is a 17-item semi-structured interview with good internal consistency, item-total correlations, and concurrent and convergent validity (Foa et al., 1993).

2.3.2. Change motivation—The Stages of Change Readiness and Treatment Eagerness Scale (SOCRATES; Miller & Tonigan, 1996) is a 19-item self-report instrument that was used to assess participants' motivation for change. Participants endorsed items on 1 (*No! Strongly disagree*) to 5 (*Yes! Strongly agree*) scales. Sample items include, "I really want to make changes in my drinking," and "My drinking is causing a lot of harm." The SOCRATES has demonstrated acceptable reliability, as well as good convergent and discriminant validity (Carey, Maisto, Carey, & Purnine, 2001; Miller & Tonigan, 1996). The SOCRATES yields three sub-scales: Ambivalence, Recognition, and Taking Steps. Because the Ambivalence sub-scale addresses a construct that is not clearly aligned with strength of motivation to change, only the items from the Recognition ($\alpha = .88$) and Taking Steps ($\alpha = .88$) scales were summed for use in the analysis. Higher scores indicate greater motivation to change.

2.4. Daily IVR Assessment

2.4.1. Alcohol use—Participants indicated the number of standard drinks of beer, wine, and liquor (defined as 12 oz. of beer, 5 oz. of wine, and 1–1.5 oz. of liquor) they consumed the previous day, each queried separately, and added together to get the total number of drinks per day.

2.4.2. Alcohol craving—Three items were used to reflect alcohol craving: "How much did you think about drinking yesterday?" "How strong were your cravings yesterday?" and "What was your average level of craving for alcohol yesterday?" These items were rated on 0 to 8 scales, where 0 indicated no thoughts about drinking/craving and 8 indicated very frequent thoughts about drinking/strong craving. These items were summed to form the primary alcohol craving variable.

2.4.3. Craving avoidance and craving resistance—One item was used to assess craving avoidance ("How much did you try to avoid thoughts and feelings of craving yesterday?") and one item was used to assess craving resistance ("How much did you resist or try not to give in to your craving yesterday?") Both items were rated on 0 (*no avoidance or resistance*) to 8 (*the most avoidance or resistance ever*) scales; these questions were only asked if any of the craving items were endorsed with a 1 or higher. Although we initially conceptualized these items as tapping separate constructs, the empirical results did not support this idea (see details below in the Descriptive Statistics section). As a result, the two items were combined to form a single composite variable referred to as craving control.

2.5. Analysis

To examine the hypothesized associations between study variables and daily reports of alcohol use, we utilized generalized estimating equation (GEE; Hardin & Hilbe, 2003) models in Stata 13 (Stata Corp, 2013). The outcome variable consisted of participants' daily reports of the number of standard drinks consumed. Because this variable represents a count that was positively skewed, negative binomial distributions with log-link functions were specified, and we obtained robust standard errors. Our initial model examined within-person associations between alcohol craving and craving control (i.e., craving avoidance/craving resistance composite variable) on total number of drinks consumed, as well as the main effects of gender, age, marital status and motivation for change. This main effects model also included a "weekend day" indicator to account for the fact that more drinking often occurs on weekends compared to weekdays. Craving and craving control variables were centered at the person mean prior to model entry and formation of interaction terms. Centering these variables at the person-mean allows for an examination of the purely within-person relationship between changes in craving and changes in craving control independent of between-persons associations (Enders & Tofighi, 2007; Raudenbush & Bryck, 2002). Baseline motivation to change, a between-persons variable, was centered at the grand mean prior to model entry and formation of interaction terms (Raudenbush & Bryck, 2002). To examine hypotheses regarding the moderating role of craving control and motivation to change, a second model was examined, which included the above-listed variables as well as all possible two-way interaction terms between craving, craving control, and change motivation¹.

Participant IVR response rates were excellent during this baseline period, with only 4.7% of the possible assessment days missing. In addition, among the completed IVR assessments, less than 1% of the items assessed were skipped or incomplete. Given the low rate of missingness and the inclusion of relevant variables in the model, the quasi-maximum likelihood procedures used in the following analysis likely produced unbiased estimates of hypothesized relationships (Allison, 2009) and GEE models are likely robust to missingness of this nature.

3. Results

3.1. Descriptive Statistics

Participants in the analyzed sample ($N = 84$) spent an average of 7.3 ($SD = 2.6$, range = 4 to 16) days completing daily IVR assessments before receiving their assigned treatment intervention. A total of 612 person-days were analyzed. Participants reported drinking an average of 4.1 days ($SD = 3.1$, range = 0 to 12). Participants reported drinking an average of 4.0 ($SD = 6.6$) drinks per day during this period. Men ($M = 5.6$, $SD = 8.4$) reported drinking more per day than women ($M = 2.6$, $SD = 3.7$), $t(611) = -5.72$, $p < .001$. Participants who were not currently married (e.g., never married, divorced, separated, widowed; $M = 4.4$, SD

¹This model was also run with the ambivalence subscale included in the SOCRATES motivation for change total score and the results did not change.

= 6.9) reported consuming significantly more drinks per day compared with those who reported being married ($M = 1.6$, $SD = 3.3$), $t(611) = 3.40$, $p < .001$.

Although we initially hypothesized that craving resistance and avoidance would reflect two distinct constructs, examination of bivariate correlations suggested that these were highly, positively associated ($r = .74$, $p < .001$). As such, these items were combined in order to reflect an overall “craving control” variable that reflects both efforts to avoid and resist cravings for inclusion in the full analysis. See Table 2 for descriptive statistics and sample correlations.

3.2. Main Effects Model

In our initial model (Table 3), male gender was positively associated with daily drinking (incidence rate ratio [IRR] = 2.42, 95% confidence interval [CI]: 1.51 – 3.85; $p < .001$). Being married was significantly associated with decreased alcohol use (IRR = 0.40, 95% CI: 0.22 – 0.73; $p = .003$). In addition, more alcohol was consumed on weekend days than on weekdays (IRR = 1.28, 95% CI: 1.09–1.49; $p = .002$). Further, daily craving was positively related to alcohol use (IRR = 1.13, 95% CI: 1.10–1.16; $p < .001$). This indicates that a 1-unit increase in craving above the person’s average was associated with a 13% increase in drinking that day. On average, among men, this translates into .73 drinks per 1-unit increase in craving and among women this translates into .34 drinks per 1-unit increase in craving. Baseline motivation to change was negatively related to alcohol use (IRR = 0.97, 95% CI: 0.95 – 0.99; $p = .001$). This suggested that a 1-unit increase in baseline motivation was associated with a 3% decrease in drinking. On average, among men, this translates into a decrease of .17 drinks per 1-unit increase in motivation and among women this translates into a decrease of .08 per 1-unit increase in motivation. Finally, daily efforts to control craving were negatively related to alcohol use (IRR = 0.93, 95% CI: 0.90 – 0.96; $p < .001$). This suggested that a 1-unit increase in control efforts above the person’s average was associated with a 7% decrease in drinking that day. On average, among men, this translates into a decrease in .39 drinks per 1-unit increase in craving control and among women this translates into a decrease of .18 drinks per 1-unit increase in craving control.

3.3. Moderator Model

Results from our second model (Table 4) examining possible moderators of the relationship between craving and alcohol use paralleled our initial findings. Male gender, being single, and weekend days were associated with more drinking. Daily alcohol craving, craving control, and change motivation significantly predicted daily drinking. However, these main effects were superseded by significant two-way interaction effects between craving and change motivation (IRR = 1.00; 95% CI: 1.00–1.01; $p < .001$) and craving and craving control (IRR = .99, 95% CI: 0.99–0.99; $p = .001$). The significant interaction between baseline change motivation and daily craving suggests the association between craving and alcohol use was significantly stronger for those with low baseline change motivation (Figure 1). Further, the significant interaction between craving control and daily craving suggests participants were more likely to consume alcohol when experiencing high levels of craving if they reported low levels of craving control (Figure 2). The interaction between craving control and motivation to change was not significant.

4. Discussion

The present investigation sought to replicate previous frequent monitoring study results detecting a positive association between craving and alcohol use in a sample with co-occurring PTSD/AUD and to extend these findings by exploring possible moderators of this relationship. Baseline motivation to change alcohol use was examined as a potential moderator of the relationship between daily craving and daily consumption and the relationship between daily craving control and daily consumption. Within-day associations among self-reported alcohol craving, efforts to control craving, and their potential interactions on daily drinking were also examined. Consistent with our hypotheses, we found that reports of alcohol craving were indeed associated with higher levels of alcohol use. In addition, both baseline change motivation and craving control interacted with craving to predict alcohol use. The interaction between change motivation and craving control was not significant. Each of these findings is discussed in turn.

Similar to previous investigations using frequent monitoring protocols in AUD only samples, our results demonstrate a relationship between the subjective experience of alcohol craving and alcohol use. Indeed, a 1-unit increase in craving above one's average level of craving on a given day was associated with consuming an increase of .73 standard drinks among men and .34 among women that day. In other words, even a very small increase in craving above the individual's average was associated with a notable increase in alcohol consumption. Extrapolating out to larger increases in craving, a relatively moderate increase of 7 points above one's average on the IVR craving index (range is 0 to 24) on a given day would be associated with 5 more standard drinks for men and nearly 2.5 more standard drinks for women on that day. This result is consistent with a number of studies demonstrating global relationships between self-reported craving and a variety of deleterious alcohol-related outcomes (Kavanagh et al., 2009; Flannery et al., 1999; Grusser et al., 2006; Love et al., 1998). Our results also lend support to those reported by Litt and colleagues (2000) suggesting that craving frequently co-occurs with drinking at the situational level, and we extend their finding by demonstrating that modest increases in craving are associated with clinically meaningful increases in same-day alcohol consumption in a PTSD/AUD sample. Together, these studies affirm craving as an important predictor of drinking in the daily lives of those with an AUD as well as in those with PTSD/AUD, and suggest that efforts to prevent or ameliorate craving are likely critical to treatment success for individuals who are seeking to reduce or quit drinking.

In order to extend our understanding of the relationship between craving and consumption we examined baseline change motivation as it pertains to craving and to daily drinking. As hypothesized, we found a main effect of baseline change motivation such that greater motivation to change alcohol use was associated with less drinking. However, in our second model, this main effect was superseded by a significant interaction effect between craving and change motivation, indicating that change motivation appears to play at least a small role in tempering the impact of craving on drinking (see Figure 1). More specifically, those with stronger motivation to reduce or quit drinking at the beginning of treatment reported less consumption when they experienced craving. Previous studies have consistently detected a relationship between motivation to change and positive post-treatment outcomes

in AUD only samples (e.g., Adamson et al., 2009; Evern et al., 2010; Ray et al., 2006). To our knowledge this is the first attempt to extend these findings by examining the relationship between craving and motivation to change as it relates to alcohol use. Although this finding will need to be confirmed through future research, our results appear to support current clinical recommendations regarding the importance of assessing and understanding a patient's level of change motivation and delivering targeted motivational enhancement interventions to those with lower change motivation (Miller & Rollnick, 2013). This work could be further extended in the future by examining the role of both internal and external sources of motivation and the associated impact on the craving-use relationship.

In addition, we evaluated craving control efforts as they pertain to craving itself and to daily drinking. First, we found a main effect of craving control efforts such that greater control efforts were associated with less same day alcohol use. However, upon adding interaction terms to our second model, this main effect was superseded by a significant interaction between craving and craving control efforts, indicating that craving control serves to moderate the relationship between craving and daily drinking.

Germane to these findings, our single item assessments of avoidance of thoughts and feelings associated with craving and of efforts to resist craving were highly positively correlated, suggesting that they are likely not orthogonal constructs. Although some previous literature suggests that avoidance of thoughts about craving appears to be associated with greater accessibility of alcohol-related memories or imagery (Klien et al., 2007; Palfai, Monti, Colby, & Rohsenow, 1997), both our findings and those of Kavanaugh et al. (2009), suggest increased craving control efforts, including efforts to avoid thoughts and feelings pertaining to alcohol, are related to *reduced* drinking. It may be that while thought suppression leads to a cognitive rebound of the avoided material, there is not a corollary relationship between thought suppression and associated overt behavior. Future research is needed to determine whether specific types of avoidance and resistance control efforts are more or less related to successful reductions in use. Additionally, examining variables that may impact these cognitive processes (e.g., ambivalence, situational variables) may also be a fruitful line of research. For instance, in our study, married participants drank significantly less than single participants. It stands to reason that those who are unmarried have less access to immediate social support that could be used either as a behavioral avoidance strategy or to shore up flagging motivation. It is possible these individuals may benefit from additional tools when thinking about utilizing such control efforts (e.g., being more creative about who he/she can call to take his/her mind off of alcohol).

Regardless of the exact mechanism of action, our craving control results suggest that efforts to avoid or resist alcohol cravings may, in fact, be helpful to those with PTSD/AUD who are attempting to change their drinking. Despite the fact that there is no fail safe in that strong control efforts in the face of craving cannot guarantee abstinence, the finding that greater control efforts appear to help reduce, somewhat, the amount of drinking and may impact the relationship between craving and subsequent alcohol use is noteworthy, though the degree of clinical significance does appear limited (see Figure 2). Given that our study examined individuals with AUD and PTSD, a disorder characterized by avoidance, it is important to highlight the seemingly contradictory results detected in the present study. More

specifically, studies examining individuals with PTSD suggest high levels of avoidance are associated with poorer psychological outcomes (e.g., Badour, Blonigen, Boden, Feldner, & Bonn-Miller, 2012). This suggests that the function of avoidance, and thus the subsequent treatment of avoidant behaviors, may differ in the context of each disorder. Nuanced conversations with patients diagnosed with PTSD/AUD focused on building understanding of when avoidance may be appropriate may be needed. For example, using avoidance as a control strategy may be appropriate for coping with distressing alcohol cravings in order to maintain abstinence, but it is likely not appropriate as a control effort to decrease distressing anxiety associated with situations most would consider safe.

Finally, the relationship between craving control efforts and change motivation was also explored and we did not detect a significant interaction. This somewhat surprising finding suggests that baseline motivation to change alcohol use did not influence the association between one's use of craving control efforts and their alcohol consumption on that day. Motivation to change is often conceptualized as a dynamic state (Miller & Rollnick, 2013; Prohaska & DiClemente, 1982). Thus, it may be that the relationship between craving control efforts and change motivation would best be examined when both variables are measured at the event-level via a frequent monitoring protocol.

4.1. Strengths and Limitations

This study has a number of notable strengths such as the use of frequent daily assessments that allow for close to real time assessment of the variables of interests as well as the examination of day-to-day variability within individuals. Further, the comorbid PTSD/AUD sample examined has approximately even numbers of men and women. The sample was also comprised of individuals seeking to make a change in their drinking and thus the current examination of craving and potential moderators of craving is highly clinically relevant.

There are, however, several pertinent limitations. First, the measure of craving employed in the daily monitoring protocol consisted of a relatively small number of items and it pertained only to alcohol. Although the administration of lengthy assessments should be balanced with advantages offered via situation-level design strategies, inferences based on our abbreviated approach should be interpreted with some caution and craving for substances other than alcohol need to be considered. In addition, this study focused on self-reported craving, and other measures of craving (e.g., psychophysical measures) may exhibit distinct relationships with substance-related outcomes. It is also possible that self-reported craving and alcohol use may be related via a third variable, such as willingness to report alcohol-related experience. That is, those who were willing to report craving may also be likely to report use. Further, as noted above, the assessment of craving avoidance and craving resistance were limited to one item each in the daily monitoring protocol.

The study sample was also comprised solely of treatment seeking individuals with both AUD and PTSD and as such, we do not know whether this pattern of results is generalizable to non-treatment seekers and/or people with AUD only or with AUD and other comorbidities. Although we have no specific reason to expect there to be pronounced differences between this group and other groups with AUD on these craving constructs, it is possible that individuals with PTSD could be especially reactive to discomfort associated

with craving, perhaps leading to greater drinking to dampen the associated distress (Saladin et al., 2003). Because we used a daily data collection model rather than an ecological momentary analysis one, we were also unable to evaluate the exact temporal sequencing of craving, control efforts, and drinking could not be established by the single daily assessment measurement protocol employed in this study, our findings should be interpreted with caution. Finally, the results reported in this study are correlational, and as such, should not be interpreted as causal. Future studies that include more frequent monitoring assessments are needed to begin to examine the temporal relationships between these important constructs.

4.2. Summary

The present study replicates and extends previous research on the relationships among craving, efforts to control craving, and alcohol use by investigating these associations at the situational level in a sample of individuals with comorbid AUD and PTSD and further evaluating the role of baseline change motivation. Taken together, study findings contribute important information to the addictions treatment literature by highlighting the significance of craving in maintaining use in those attempting to change their drinking as well as the potential buffering effect of baseline change motivation and craving control efforts. These findings lend support for interventions targeting motivation to change (Smedslund et al., 2011), as well as for those that facilitate stronger control and amelioration of craving among individuals diagnosed with PTSD/AUD attempting to decrease or abstain from alcohol (Hendershot, Witkiewitz, George, & Marlatt, 2011).

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Highlights

- Daily craving was positively related to alcohol use in individuals with AUD/PTSD.
- Greater change motivation was negatively related to alcohol use.
- Efforts to resist/avoid craving were negatively related to alcohol use.
- The craving-use relationship was stronger for those with low change motivation.
- Those with low craving control were more likely to drink at high craving levels.
- Efforts to ameliorate craving may be critical for treatment success.



Figure 1. Relationship between Alcohol Craving and Daily Standard Drinks by Levels of Change Motivation. Estimated values were plotted 1 standard deviation above and below the mean for change motivation.

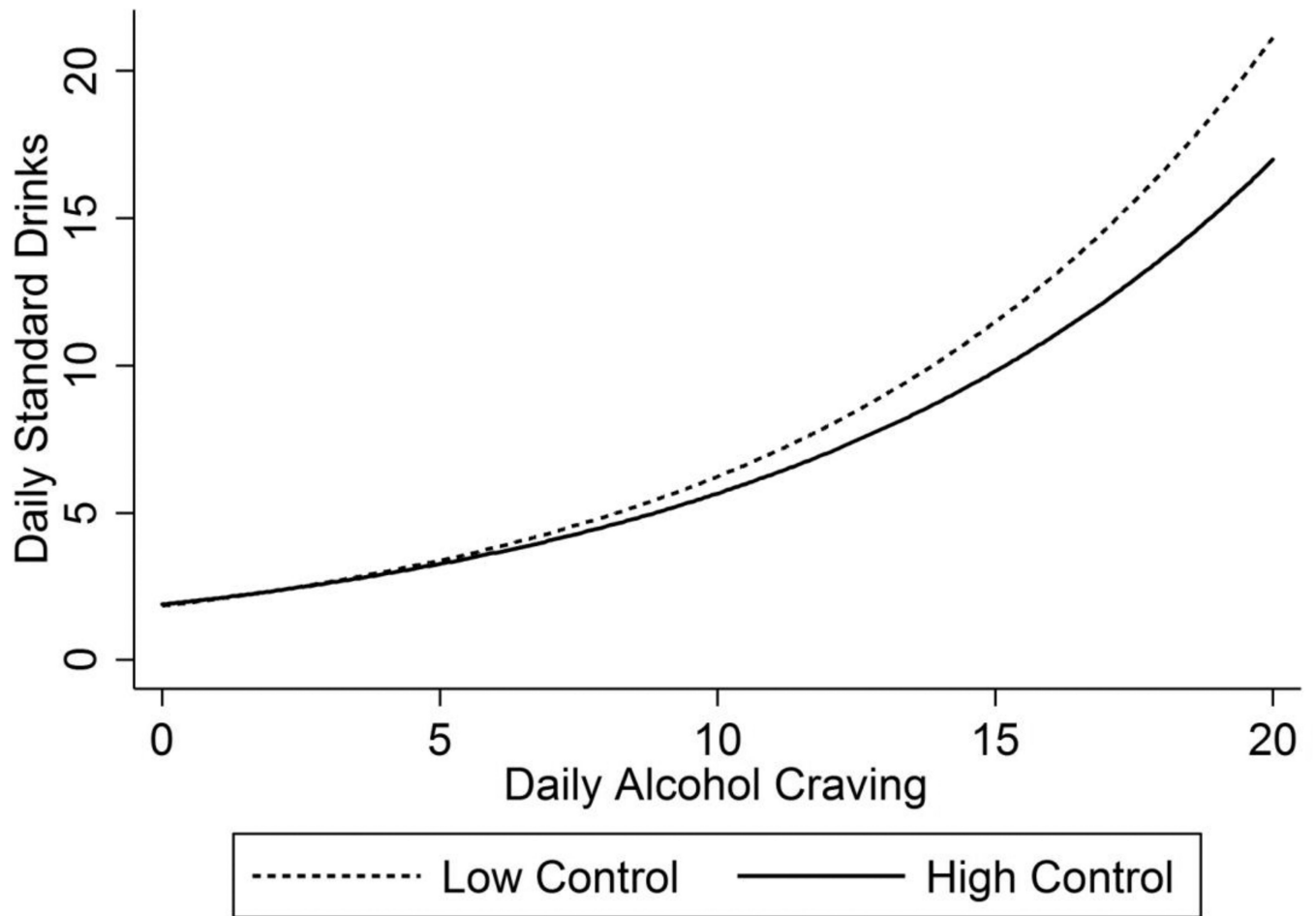


Figure 2. Relationship between Alcohol Craving and Daily Standard Drinks by Levels of Craving Control. Estimated values were plotted 1 standard deviation above and below the mean for craving control.

Table 1

Participant Characteristics

Characteristics	Mean (SD) or N (%)
Female	41 (48.8)
Age (<i>M</i> ± <i>SD</i>)	44.7 (11.1)
Ethnicity/Race	
Caucasian	34 (40.5)
African American	36 (42.9)
Hispanic/Latino	4 (4.8)
Native American	4 (4.8)
Asian American	1 (1.2)
Other or missing	5 (6.0)
Marital Status	
Married or partnered	11 (13.1)
Divorced or separated	31 (36.9)
Never married	35 (41.7)
Widowed or other	7 (8.3)
Housing Stats	
Living in own home	51 (60.7)
Homeless	20 (23.8)
Other	13 (15.5)
Educational Attainment	
Did not graduate HS	19 (22.6)
Graduated HS	12 (14.3)
At least some college	53 (63.1)
Employment Status	
Employed at least part-time	11 (13.1)
Unemployed	27 (32.4)
Student	9 (10.7)
Disabled/Retired/Other	37 (43.8)
Treatment History	
Inpatient substance abuse	41 (48.8)
Inpatient mental health	23 (27.4)
Medication management	50 (59.5)
Outpatient therapy	57 (67.8)

Table 2

Descriptive statistics and bivariate correlations of study variables

Variables	Range	Mean	SD	1	2	3	4	5	6
1. Gender	0 – 1	N=41/43	--						
2. Age	21 – 63	44.65	11.14	0.09*					
3. Marital status	0 – 1	N=73/11	--	-0.04	-0.15***				
4. Drinks per day	0 – 54	4.02	6.63	0.25***	-0.02	-0.14***			
5. Alcohol craving	0 – 24	13.61	7.07	0.03	0.02	-0.003	0.36***		
6. Craving control	0 – 16	7.68	5.29	0.11**	0.10*	0.04	-0.15***	0.27***	
7. Change motivation	0 – 75	56.45	14.89	0.06	0.11**	0.01	-0.14***	-0.08	0.12**

Note. Gender was coded 0 = female, 1 = male. Marital status was coded 0 = not married, 1 = married.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Table 3
Main Effects GEE Model of Same-Day Standard Drinks Consumed on Alcohol Craving, Craving Control Efforts, and Change Motivation

Variable	b	SE	p	IRR	95% CI
Age	-.008	.009	.390	0.99	0.97, 1.01
Male gender	.882	.238	< .001	2.42	1.51, 3.85
Married	-.916	.306	.003	0.40	0.22, 0.73
Weekend Day	.247	.078	.002	1.28	1.10, 1.49
Alcohol craving	.122	.012	< .001	1.13	1.10, 1.16
Craving control	-.078	.017	< .001	0.93	0.90, 0.96
Change motivation	-.029	.009	.001	0.97	0.95, 0.99

Note. Wald $\chi^2(7) = 149.11, p < .001$. *IRR* = Incidence rate ratio. Alcohol craving, craving control, and change motivation were standardized prior to entry.

Table 4
Final GEE Model of Same-Day Standard Drinks Consumed on Alcohol Craving, Craving Control Efforts, and Change Motivation

Variable	<i>b</i>	<i>SE</i>	<i>p</i>	<i>IRR</i>	95% <i>CI</i>
Age	-.008	.008	.366	0.99	0.97, 1.01
Male gender	.891	.237	<.001	2.44	1.53, 3.88
Married	-.910	.299	.002	0.40	0.22, 0.73
Weekend Day	.240	.082	.004	1.27	1.08, 1.49
Alcohol craving	.116	.012	<.001	1.12	1.10, 1.15
Craving control	-.070	.017	<.001	0.93	0.90, 0.97
Change motivation	-.032	.009	<.000	0.97	0.95, 0.99
Craving × craving control	-.006	.002	.001	0.99	0.99, 1.00
Craving × motivation	.001	<.001	.008	1.00	1.00, 1.01
Craving control × motivation	-.001	<.001	.176	0.999	0.99, 1.00

Note. Wald $\chi^2(10) = 210.36, p < .001$. *IRR* = Incidence rate ratio. Alcohol craving, craving control, and change motivation were standardized prior to entry.