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An Experience Sampling Study of PTSD and Alcohol Related Problems

Raluca M. Gaher*,

Department of Psychology, The University of South Dakota; Jerome Buchkoski, Sioux Falls VA Healthcare System

Jeffrey S. Simons,

Department of Psychology, The University of South Dakota; Jerome Buchkoski, Sioux Falls VA Healthcare System

Nicole L Hahn,

Department of Psychology, The University of South Dakota; Jerome Buchkoski, Sioux Falls VA Healthcare System

Jamie Hansen Hofman,

Department of Psychology, The University of South Dakota; Jerome Buchkoski, Sioux Falls VA Healthcare System

Jamie Hansen Hofman, and

Department of Psychology, The University of South Dakota; Jerome Buchkoski, Sioux Falls VA Healthcare System

Jerome Buchkoski

Sioux Falls VA Healthcare System

Abstract

Posttraumatic stress disorder (PTSD) represents a debilitating psychiatric condition that is affecting the lives of many returning veterans. PTSD and alcohol use and dependence are highly comorbid. The purpose of this study was to understand the functional mechanisms between PTSD and alcohol use and problems. Specifically, the role of negative urgency and emotional intelligence were investigated as vulnerability and resiliency factors, respectively. This study utilized experience sampling to test associations between PTSD symptoms and alcohol use and related problems in a sample of 90 OIF/OEF veterans. Participants completed eight brief questionnaires daily for two weeks on palmtop computers. Elevations in PTSD symptoms during the day were associated with subsequent increases in alcohol use and associated problems that night. PTSD symptoms were associated with greater problems above and beyond the effect of drinking level at both the within- and between- person level. Emotional intelligence was associated with lower negative urgency, fewer PTSD symptoms, and less alcohol use and associated problems. The effects of emotional intelligence were primarily indirect via negative

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Correspondence concerning this article should be addressed to Raluca M. Gaher, Department of Psychology, The University of South Dakota, 414 East Clark St. Vermillion, SD 57069. rgaher@usd.edu.

urgency and the effects of negative urgency on alcohol use and problems were indirect via its positive association with PTSD symptoms. Hypothesized cross-level effects of emotional intelligence and negative urgency were not supported. The findings suggest a functional association between PTSD symptoms and alcohol consumption. The association between PTSD symptoms and alcohol consumption is consistent with a self-medication model. However, the significant associations between PTSD symptoms and alcohol problems, after controlling for use level, suggest a broader role of dysregulation.

Posttraumatic stress disorder (PTSD) represents a debilitating psychiatric condition that is affecting the lives of many returning veterans. This disorder has significant social and financial implications for society as well as the affected individuals and their families. PTSD is associated with increased rates of a range of problematic behaviors including alcohol-related problems as well as difficulties in social and occupational functioning (Mills, Teesson, Ross, Darke, & Shanahan, 2005; Mills, Teesson, Ross, & Darke, 2007). PTSD and alcohol dependence are highly comorbid, such that individuals with PTSD also have co-occurring alcohol dependence in rates as high as 41–79% (Pietrzak, Goldstein, Southwick, & Grant, 2011; Scherrer et al., 2008). Additionally, patients with comorbid PTSD and substance use disorder are at a greater risk for health problems, suicide attempts, violent behavior, and legal problems (Driessen et al., 2008; Tate, Norman, McQuaid, & Brown, 2007). Patients with comorbid substance use disorder are less likely to benefit from treatment and more likely to relapse when compared to patients who have PTSD alone (Mills et al., 2005; Norman, Tate, Anderson, & Brown, 2007; Ouimette, Goodwin, & Brown, 2006). Previous research has demonstrated that traumatic experiences, specifically combat exposure, is prospectively associated with substance-related problems, suggesting a functional etiological role of traumatic stress symptoms in the development of excessive substance use (Hooper et al., 2008).

PTSD and Substance Use: Functional Mechanisms

Retrospective and prospective studies of time-course indicate that PTSD symptoms generally precede and predict onset of alcohol or other substance use disorder (Haller & Chassin, 2012; Jakupcak et al., 2010; Ouimette, Read, Wade, & Tirone, 2010). Alcohol may be used to reduce the occurrence of intrusive traumatic memories (Reynolds, Novak, & Kouimtsidis, 2012) and provide acute symptom relief (Leeies, Pagura, Sareen, & Bolton, 2010). Also, alcohol has physiological effects that may minimize hyperarousal symptoms (Jacobsen, Southwick & Kosten, 2001; Jakupcak et al., 2010). Associations between PTSD and alcohol consumption are most commonly interpreted as due to self-medication processes (Khantzian, 2003; Leeies et al., 2010; McFarlane, 1998; Stewart, 1996). However, research indicates direct associations between PTSD and other forms of negative arousal and alcohol-related consequences independent of consumption level, suggesting that factors in addition to drinking to alleviate symptoms are relevant (Ouimette et al., 2010; Simons et al., 2005; Grekin, 2012; Park & Grant, 2005;), suggesting that factors in addition to self-medication are relevant. In addition, there is evidence suggesting that alcohol use increases vulnerability to the development of posttraumatic stress symptoms, exacerbating existing posttraumatic stress symptoms, and contributing to the maintenance of posttraumatic stress symptoms

(Jacobsen, Southwick, & Kosten, 2001; Ouimette et al., 2010). PTSD symptoms are a significant risk factor for alcohol use disorders and excessive alcohol use, which in turn, may intensify symptoms, interfere with PTSD treatment, and increase functional impairment.

Although previous research has contributed important evidence regarding the functional relationship between PTSD symptoms and substance use, there is controversy regarding the comorbidity of the two conditions and their treatment (e.g., should substance use be addressed before treating PTSD or should the conditions be treated concurrently). Survey research that focuses only on between-subject differences is unable to clearly examine the complex functional associations between PTSD symptoms and alcohol use. For example, between-person associations suggest that PTSD symptoms are prospectively associated with drinking and potential alcohol-related problems. However, they are unable to test the key hypothesis that PTSD symptoms cause increases in drinking and associated problems. In this regard, experimental analogue studies indicate that cravings among individuals with alcohol dependence increase significantly in response to trauma cues (Coffey et al. 2002; Coffey et al., 2010). Daily process type designs offer a means to bridge the gap between between-person, global-association, studies and experimental laboratory analogue studies to examine functional associations between PTSD symptoms and alcohol related behaviors in the natural environment. These within-person designs are capable of testing whether drinking patterns follow the temporal pattern of PTSD symptoms. That is, does alcohol consumption increase in response to exacerbation of PTSD symptoms and decrease when PTSD symptoms abate? In this regard, Ouimette et al. (2010) utilized the timeline follow-back to examine weekly associations between PTSD symptoms and symptoms of alcohol dependence in a treatment sample. Simpson et al. (2012) used daily Interactive Voice Response reports to assess PTSD symptomatology and alcohol craving in individuals receiving treatment for alcohol use disorder. Both of these studies demonstrated an association between increased levels of alcohol consumption or craving subsequent to symptom exacerbation. However, further research is needed to build upon these initial studies.

In addition to understanding the temporal sequence between PTSD and substance related problems, it is also important to understand how risk and resiliency factors contribute to the likelihood of such maladaptive outcomes following traumatic experiences. Many veterans do not develop PTSD or alcohol-related problems, suggesting the presence of risk or protective factors contributing to the development and maintenance of PTSD and associated alcohol problems.

PTSD and Substance Use Comorbidity: Resilience and Vulnerability Factors

Vulnerability and resilience variables for combat-related PTSD have been classified in three categories: pre-deployment factors (e.g., genetic predisposition, global intelligence, prior trauma), deployment variables (e.g., severity of combat, environmental adversity), and post-deployment factors (e.g., social support; King, King, Foy, Keane, & Fairbank, 1999). Although the rates of veterans developing PTSD range from 9% to 31% in Operation Iraqi

Freedom (OIF)/Operation Enduring Freedom (OEF) veterans (Milliken, Auchterlonie, & Hoge, 2007; Seal et al., 2009; Thomas et al., 2010), many combat veterans do not develop PTSD. Likewise, despite the strong association between PTSD symptoms and alcohol use disorder, not all veterans with PTSD symptoms develop alcohol-related problems.

Negative Urgency

Separate lines of research have indicated that impulsivity is related to alcohol consumption and problems (Burton, Pedersen, & McCarthy, 2012; Simons, 2003; Simons & Carey, 2006), as well as with PTSD (Miller & Resick, 2007; Weiss, Tull, Anestis, & Gratz, 2013). Although some research suggests that PTSD itself results in increased levels of impulsivity (Miller et al., 2006), there is a considerable body of literature connecting impulsivity to early temperament differences (e.g., disinhibition; Clark & Watson, 1999; Eysenck & Eysenck, 1985). Thus, impulsivity may also act as a factor that contributes to the development of PTSD symptoms and moderates the association between PTSD symptoms and subsequent alcohol consumption and problems. In this regard, previous research indicates that impulsivity moderates associations between both negative affect and alcohol consumption and subsequent alcohol-related problems, increasing the strength of the associations (Simons, Gaher, Oliver, Bush, & Palmer, 2005).

Multiple lines of research indicate that impulsivity is a multidimensional construct (Carver, 2005; Evenden, 1999; Whiteside & Lynam, 2001). For example, the UPPS model indicates that Urgency, Planning, Premeditation, and Sensation seeking are distinct types of impulsivity. Negative urgency represents the tendency to engage in rash and impulsive behavior when negatively aroused, despite potential long-term negative consequences (Whiteside & Lynam, 2001). Negative urgency exhibits consistent positive associations with both alcohol consumption and associated problems (Settles et al., 2010; Wray et al., 2012). Previous experience sampling research among college students indicates that negative urgency moderates associations between anxiety and alcohol consumption (Simons, Dvorak, Batién, & Wray, 2010). Importantly, negative urgency has been linked to level of PTSD symptoms in a substance use clinical sample (Weiss et al., 2013). In this study, negative urgency and, to a lesser extent, sensation seeking were associated with PTSD. However, neither lack of perseverance nor lack of persistence was associated with PTSD. Hence, we posit that negative urgency may be an important dimension of impulsivity to examine in regards to associations between PTSD and alcohol-related behavior among veterans. The current study will extend upon previous research by examining a specific facet of impulsivity, negative urgency, in relation to PTSD and alcohol problems in a sample of veterans.

Negative urgency is characterized by increased externalizing behavior when negatively aroused. Hence, we posit that it may predict greater PTSD symptoms, many of which consist of hyperreactivity to stress and negative arousal. PTSD symptoms, in turn, are expected to be associated with increased alcohol consumption and problems. Hence, negative urgency is expected to exhibit indirect associations via PTSD symptoms in this sample. Alternatively, negative urgency could be a vulnerability factor (i.e., moderator), increasing the strength of

associations between PTSD symptoms and both alcohol use and problems (cf. Simons et al., 2010).

Emotional Intelligence

In addition, the current study examines the role of *emotional intelligence* as a resilience factor. Emotional intelligence refers to the ability to *understand* and regulate emotions, as well as utilizing emotion through flexible planning, creative thinking, redirected attention and motivation (Salovey & Mayer, 1990). Previous studies indicate that general intelligence is a resilience factor in the development of PTSD. Individuals with lower pre-combat intelligence were more likely to develop PTSD symptoms even after adjustment for the extent of combat exposure (Saltzman, Weems, & Carrion, 2006; Vasterling et al., 2002). Although the relationship between emotional intelligence and PTSD and substance use comorbidity has not been systematically studied, high emotional intelligence has emerged as a significant predictor of decreased alcohol consumption and problems (Austin, Saklofske, Egan, 2005; Claros & Sharma, 2012; de Sousa Uva et al., 2010), as well as decreased psychological symptoms related to traumatic experiences (Hunt & Evans, 2004). Although research on emotional intelligence as a resilience factor for PTSD is somewhat limited, emotional intelligence is clearly associated with better interpersonal functioning and social support (Austin et al., 2005). In turn, social support is a well-established, robust post-deployment predictor of reduced rates of PTSD and associated problems (Brewin, Andrews, & Valentine, 2000). Finally, there is emerging evidence that emotional intelligence has been associated with borderline personality symptoms via its effects on negative urgency (Gaher, Hofman, Simons, & Hunsaker, 2013). Emotional intelligence may thus have similar indirect effects on PTSD symptoms and alcohol related problems, via its inverse association with negative urgency (i.e., a mediating mechanism). Alternatively, as with negative urgency, emotional intelligence may act as a moderator, reducing the association between PTSD symptoms and alcohol use and problems. That is, the ability to understand and regulate emotions, may act to reduce maladaptive responses to heightened negative arousal.

Current Study

The current study investigates both within- and between- person associations to address current gaps in the literature regarding the functional mechanisms underlying PTSD and substance use. The between-person analyses look at covariation in mean levels of symptoms and behaviors in the sample. For example, do individuals who have higher mean levels of PTSD symptoms have higher mean levels of alcohol problems? Conversely, the within-person analyses examine covariation between symptoms and behaviors within the person across time. For example, do individuals report elevated drinking problems on days when they had elevated PTSD symptoms? While between person analyses are useful for understanding shared vulnerabilities (i.e., are individuals with PTSD at elevated risk for comorbid alcohol use problems), the within person analyses are closer to evaluating functional relationships (i.e., do individuals tend to drink more subsequent to elevations in PTSD symptoms and, conversely, drink less on days when they are symptom-free?). Although these designs do not permit the type of causal inference that an experiment would do, it allows one to examine stimulus-response type relationship in a natural environment.

The current study utilizes experience sampling to examine associations between PTSD symptoms, negative urgency, emotional intelligence, drinking, and associated problems in a sample of OIF/OEF veterans. Experience sampling methods (ESM) utilize a device (e.g., palmtop computer) to randomly assess and sample behavior in an individual's natural environment (Csikszentmihalyi & Larson, 1987). ESM and the closely related ecological momentary assessment (EMA) approaches provide near real-time assessment of behavior. These methods offer substantial benefits by minimizing memory biases associated with retrospective reports and via the time-stamped data facilitating accurate assessment of temporal relationships (Shiffman 2009). Prior research demonstrates the reliability and validity of ESM assessment of individual's daily experiences including both emotional experience and substance use behavior (Carney et al., 1998; Csikszentmihalyi & Larson, 1987; Simons, 2005, 2010; Shiffman, 2009; Trull & Ebner-Preimer, 2009). Based on the previous literature, we test the following within-person, between-person, and cross-level hypotheses.

Within-person hypotheses

PTSD symptoms during the daytime were hypothesized to be associated with greater alcohol consumption (Hypothesis 1a) and a greater number of alcohol-related problems (Hypothesis 1b) that night. Alcohol consumption was hypothesized to be associated with a greater number of alcohol problems (Hypothesis 2).

Between-person hypotheses

At the between-person level, PTSD and alcohol consumption are the subject means across the two-week experience sampling period and alcohol problems is the random intercept. The between-person model is a hypothesized chain linking emotional intelligence to negative urgency to PTSD symptoms to alcohol consumption to alcohol problems. In addition, PTSD symptoms are expected to be directly associated with alcohol problems over and above the effect of alcohol consumption. Specifically, emotional intelligence was expected to predict higher negative urgency (Hypothesis 3a) and to have indirect associations with PTSD symptoms (Hypothesis 3b), drinking (Hypothesis 3c), and alcohol problems (Hypothesis 3d) via this effect. Negative urgency, in turn, was expected to predict greater PTSD symptoms (Hypothesis 4a) and to be indirectly associated with the alcohol consumption (Hypothesis 4b) and problems (Hypothesis 4c) via this effect. PTSD symptoms were hypothesized to be associated with greater alcohol consumption (Hypothesis 5a) and to exhibit both an indirect association with alcohol problems via consumption (Hypothesis 5b) as well as a direct association with problems above and beyond the effect of consumption (Hypothesis 5c). Finally, alcohol consumption was expected to be associated with greater alcohol problems at the between-person level (Hypothesis 6).

Cross-level interactions

In addition, we hypothesized several *moderating* effects. Negative urgency was expected to moderate the within-person associations between PTSD symptoms and alcohol consumption (Hypothesis 7a) and alcohol problems (Hypothesis 7b), increasing the strength of the associations. In contrast, emotional intelligence was expected to moderate within-person

associations between PTSD symptoms and the alcohol outcomes, decreasing the strength of the associations (Hypotheses 8a and 8b).

METHODS

Participants

Participants included 90 OIF/OEF veterans ages 18 – 50 who drank at least 1 drink/week. Exclusion criteria included psychosis and severe alcohol dependence. This was determined by a combination of unstructured interviews, and, when applicable, the judgment of the referring clinicians. Participants were recruited from the local VA and surrounding community. Participants were recruited via referrals from the VA, postings on the VA campus, and advertisements in local media.

Measures

The proposed study included two stages. Stage one consisted of a retrospective self-report baseline survey assessment. The assessment included demographic characteristics and military experience, measures of PTSD symptoms, alcohol consumption and problems, negative urgency, and emotional intelligence. Stage two consisted of collecting real-time data by the use of palmtop computers (See Table 1). Participants carried palmtop computers that were programmed to randomly alert them to complete a brief questionnaire eight times a day. In addition, participants initiated a morning assessment to report additional events from the previous night. Palmtop questionnaires recorded the occurrence of PTSD symptoms, negative affect, alcohol consumption and experience of alcohol-related problems.

Stage 1: Baseline measures

The assessment included the following baseline measures that were completed at the commencement of the study, prior to initiating the ESM assessments:

Demographics. Participants' age, gender, race, ethnicity, and military history were assessed. In addition, risk and resiliency issues specific to OIF/OEF veterans were assessed by the Deployment Risk and Resilience Inventory (DRRI; King, King & Vogt, 2003).

PTSD was assessed by the 17-item National Center for PTSD Checklist of the Department of Veterans Affairs (Blanchard, Jones-Alexander, Buckley, & Forneris, 1996; Weathers, Litz, Herman, Huska, & Keane, 1993). The PCL items correspond to DSM-IV criteria and symptoms in the past month are rated on a 5-point scale ranging from "not at all" to "extremely." The scale is internally consistent ($\alpha = .97$) and has good sensitivity (.82) and specificity (.83) with a cut-score of 50 in predicting PTSD diagnoses among veterans (Weathers et al., 1993). In the current sample Cronbach's alpha for the PCL was .88. The PCL was used for sample description and to assess criterion validity of the experience sampling assessments of PTSD symptoms.

Drinking Variables. The Modified Daily Drinking Questionnaire (DDQ-M; (Dimeff, Baer, Kivlahan, & Marlatt, 1999) consisting of a grid representing the seven days of the week was used to assess participants' typical weekly quantity of alcohol consumption in the last

month. The grid assesses participants' typical daily alcohol consumption and hours spent drinking for a typical week during the last six months. Typical weekly consumption was calculated by summing the number of standard drinks (one standard drink is equal to 12 oz. beer, 5 oz. wine, or 1.5 oz. liquor) across the number of drinking days reported by the participant. The DDQ has demonstrated good reliability and validity (Baer et al., 2001; Marlatt et al., 1998). The DDQ has also demonstrated moderate correlations with other measures of drinking quantity and alcohol problems, with correlations ranging from .49 to .50 (Collins et al., 1985; Shishido, Gaher, & Simons, 2013). The DDQ was used for sample description. Alcohol dependence symptoms in the last month were by the 25-item Alcohol Dependence Scale (ADS) assessed symptoms of heavy alcohol use and dependence such as withdrawal symptoms, blackouts, and impaired control over drinking (Skinner & Allen, 1982). These were used for descriptive purposes. The ADS has demonstrated good reliability and validity (Allen et al., 1994; Doyle & Donovan, 2009; Drake, McHugo, & Biesanz, 1995). The ADS was used for sample description.

Personality Variables. *Negative urgency* was assessed by the UPPS Impulsive Behavior Scale negative urgency subscale (Whiteside & Lynam, 2001). UPPS Impulsive behavior scale is a 45-item scale. The negative urgency subscale consist of 12 items such as "When I feel bad, I will often do things I later regret in order to make myself feel better now" "When I am upset I often act without thinking" "I have trouble controlling my impulses." The UPPS has demonstrated good internal consistency, divergent, and external validity (Whiteside & Lynam, 2001). Past reliability estimates for each subscale have ranged from .83 to .89 (Whiteside & Lynam, 2005). In the current study Cronbach's alpha for the negative urgency was .92. Emotional Intelligence was assessed by the Emotional Intelligence Scale (Schutte et al., 1998). The EIS consists of 33-items responded to on a 5-point scale. This scale has been used extensively in the literature and has good psychometric properties (Austin, Saklofske, Huang, & McKenney, 2004; Petrides & Furnham, 2000). Cronbach's alpha for the EIS in the current study was .92.

Stage 2: Experience Sampling Measures

Stage two consisted of collecting real-time data by the use of palmtop computers. Participants carried palmtop computers that were programmed to randomly alert them to complete a brief questionnaire on the machine eight times a day between the hours of 10 am and 2 am. The palmtop computers were programmed to collect 112 in vivo assessments (i.e., 8 times a day for 14 days). In addition, participants initiated a morning assessment each day to assess behaviors unlikely to have been captured by the in vivo assessments the previous night (e.g., passing out).

PTSD. The occurrence of PTSD symptoms in the previous 30 minutes was assessed by a modified version of the 17-item National Center for PTSD Checklist of the Department of Veterans Affairs (Weathers et al., 1993). Items reflect re-experiencing, arousal, and avoidance PTSD clusters were displayed in checklist form. Examples include: Having physical reactions (e.g., heart pounding, trouble breathing, sweating) when something reminded you of the stressful experience. Having difficulty concentrating. Avoiding thinking about or talking about the stressful experience or avoiding having feelings related

to it. The items were modified to fit on the palmtop screen. Participants were instructed to answer items in respect to their stressful military experience, but this was not repeated in each questionnaire in order to decrease potential reactivity.

Alcohol Consumption was assessed using two distinct approaches. First, in vivo assessments of consumption were conducted using two items in the ESM assessment. During this assessment, participants reported the number of drinks they consumed over the past 30 minutes on a 7- point scale (0 – 6 or more drinks) and how intoxicated they were (1 [not at all] – 11 [extremely]). Definitions of standard drinks were provided during the palmtop training. Second, total number of drinks during the previous night was assessed during each morning report. Participants were also asked to estimate their subjective level of intoxication during the drinking episode; participants responded on a 1 (not at all) to 11 (extremely) response scale. The combination of these two assessments (morning reports and ESM reports) provides a more reliable estimate of drinking behavior and consumption for each day. A standardized mean of assessments of drinking during the night was the measure of alcohol consumption.

Alcohol Problems in the past 30 minutes was assessed by a 14-item checklist. Items were derived based on review of existing measures (e.g., RAPI, DrInC; Miller, Tonigan, & Longabaugh, 1995; White & Labouvie, 1989). A series of checklists asked, “Have any of the following occurred in the last 30 minutes? (check all that apply)” and included the following choices: (1) neglected responsibilities, (2) gotten in an argument or fight, (3) spent too much money, (4) did something impulsive you regret, (5) acted badly or did something mean, (6) felt guilty or ashamed, (7) taken foolish risks, (8) family/friends worried or complained about your behavior, (9) friend or love relationship harmed by your behavior, (10) felt sick or vomited, (11) drank when you promised yourself not to, (12) had withdrawal symptoms, (13) tried unsuccessfully to limit your drinking, cut back, or stop, or (14) drank more or for a longer time than you intended. The morning assessment assessed whether the participant; (1) passed out, (2) blacked out, (3) vomited, (4) needed to drink more than usual to get the desired effect, (5) felt less effects than usual for the amount drank the previous night, (6) whether they experience withdrawal symptoms this a.m., (7) whether they have a hangover, (8) Did you vandalize any property? (9) Did you physically assault anyone? and (10) Did you get in a verbal (not physical) argument or fight with someone? Previous research with the RAPI and DrInC supports the criterion validity of similar items when incorporated into self-report questionnaires (Miller et al., 1995; White & Labouvie, 1989). The score for alcohol problems was the total number of symptoms endorsed for each night.

Procedure

Participant recruitment was conducted by advertisements in local news media and by referral from the local VA. Potential participants were initially screened for eligibility by a research assistant (RA). The RA provided a brief overview of the study, which informed the participant that the study involves examining PTSD symptoms and alcohol use. In addition, the RA assessed whether the participant had experienced PTSD symptoms in the past month, and had at least one drink/week for the past 3 months. Individuals who appeared

eligible were invited to participate and scheduled for a baseline assessment. At the baseline assessment, the study procedures were explained and the participant provided written informed consent to the study. Participants were trained in the use of the Palm handheld (Tungsten E2's) and completed an initial assessment in the laboratory. Palm handhelds were programmed with a revised version of PMAT software (Weiss, Beal, Lucy, & MacDermid, 2004), modified by Joel Swendsen and CNRS, France. The program was configured to prompt participants to complete brief ~2 minute assessments at random times within 2-hour blocks from 10:00 am and 2:00 am. This questionnaire included the PTSD symptom occurrence, affect, alcohol consumption, and problems assessments. Each questionnaire item inquired about the participant's behavior for the past 30 minutes. Participants were asked to answer questionnaires during waking hours and could turn the machine off when they slept or otherwise would be disturbed by it. In addition, participants were requested to initiate an initial morning assessment shortly after waking. The validity of the proposed sampling design is supported by previous research (Armeli et al., 2003; Simons et al., 2005; Swendsen & Compagnone, 2000). All participants initiated the survey midweek and completed the questionnaires for approximately two weeks. Participants received monetary compensation up to \$100. *The payment was contingent on response rates. Thus, the more random questionnaire the veterans completed, the higher the payment was. Participants who completed all of the morning assessments received an additional \$5/week.*

Data handling and preparation—Preliminary analyses were conducted to determine the ranges and distributions of variables. Outliers determined by box plots and/or z scores (z score of > 3.29 , i.e., a likelihood of $p < .001$) were examined and were either deleted from the data set or reduced in value to one unit greater than the nearest non-outlying value if appropriate (Tabachnik & Fidell, 2001). Continuous time-varying variables were centered at the subject mean and continuous time-invariant variables were centered at the grand mean (Raudenbush & Bryk, 2002). The subject means of the alcohol outcomes and PTSD symptoms were included at Level 2 of the model (i.e., between-person).

We utilized multiple imputation to replace missing variables in the analyzed data matrix. The proportion of missing data ranged from 0.00% (covariance of L2 alcohol consumption and L2 PTSD symptoms) to 16.6% (covariance of L1 Alcohol problems and Wednesday indicator). Ten datasets were imputed using Bayesian estimation of the model in Mplus 7 (Asparouhov & Muthén, 2010; Muthén & Muthén, 2012), which included all variables and interactions in the hypothesized model (Enders, 2010). These datasets were then analyzed using the maximum likelihood robust estimator (MLR) and parameter estimates and standard errors calculated using the Rubin formula (Muthén & Muthén, 2012).

Planned analyses

Multilevel regression analyses were conducted using Mplus 7.1 with the MLR estimator (Muthén & Muthén, 2012). Alcohol problems were specified as a count outcome following a negative binomial distribution with number of assessment included as an exposure variable. We conducted two main analyses, one for alcohol consumption and one for alcohol-related problems. Six indicator variables for day of the week were included to control for daily variation in drinking and symptoms. All intercepts and slopes were initially modeled as

random effects. Slopes were re-estimated as fixed effects if their residual variances were nonsignificant. Gender and age were tested for inclusion as demographic controls. The analysis strategy for the alcohol problems analysis is described below. The alcohol consumption analysis is the same aside from dropping alcohol problems from the model and treating alcohol consumption as the outcome variable. At Level 1 (i.e., within-person) nighttime alcohol problems were regressed on alcohol consumption, daytime PTSD symptoms, and the day of the week indicators. This portion of the model tests the hypothesized within-person association between daytime PTSD symptoms and nighttime alcohol problems (Hypothesis 1b) and between nighttime alcohol consumption and problems (Hypothesis 2). At level 2 (i.e., between-person), a path model was estimated whereby emotional intelligence predicted negative urgency (Hypothesis 3a), negative urgency predicted PTSD symptoms (Hypothesis 4a), PTSD symptoms predicted alcohol consumption (Hypothesis 5a), alcohol consumption predicted alcohol problems (Hypothesis 6), and PTSD had an additional direct effect to alcohol problems, over and above consumption (Hypothesis 5b). After estimating the hypothesized model, we tested whether there were additional direct effects from emotional intelligence or urgency to alcohol consumption or problems. The results of these tests determined whether hypothesized indirect effects reflected full or partial mediation. We then tested the hypothesized interactions between negative urgency and Level 1 PTSD (Hypothesis 7b) and between emotional intelligence and Level 1 PTSD (Hypothesis 8b) predicting Level 1 alcohol problems. These interactions determine whether the within-person association between daytime PTSD symptoms and subsequent alcohol problem vary as a function of negative urgency or emotional intelligence. After determining the final model (e.g., which interactions to include), we estimated the hypothesized indirect effects. The indirect effects were calculated as the cross-product of the respective direct effects and significance was determined by the ratio of the indirect effect to its standard error using the model constraint command in Mplus.

RESULTS

Descriptive statistics

Descriptive statistics are presented in Table 2. At baseline, participants reported drinking 1–80 drinks/week ($M = 24.25$, $SD = 18.58$) with a mean of 9.89 ($SD = 6.16$) on the Alcohol Dependence Scale. On the PTSD-Checklist, scores ranged from 17–84 ($M = 43.93$, $SD = 15.74$), and there was a broad range of combat trauma exposure on the DRRI (range 0–15, $M = 6.42$, $SD = 4.15$).

Compliance with the ESM protocol was good for the random assessments with 70.37% of random prompts completed and excellent for the self-initiated assessments with 88% of the morning assessments and 92% of the evening assessments completed.

Individuals drank on 52% of days, had 1–27 drinks per drinking day, and reported >1 alcohol-related problems on 43% of days. Drinking during the daytime (before 5pm) was rare, with participants reporting no drinking on 96% of daytime drinking assessments. Participants reported >1 PTSD symptom on 67%, >4 on 50%, and >14 on 25% of days. Internal consistency of the *in vivo* PTSD symptoms assessments was calculated for 1

assessment per person on 3 separate days. The mean of the KR-20 coefficients across these assessments was .88, indicating good reliability. The correlation between PCL scores at baseline and the subject mean PTSD symptom scores from the ESM data was .68, $p < .001$, supporting the convergent validity of the ESM protocol. We tested whether the repeated assessments of trauma symptoms could have an iatrogenic effect. A multilevel model regressing PTSD symptoms on day of week and day in the study indicated no substantial reactivity to the protocol ($b = -0.03$, $p = .052$). Indeed, PTSD symptoms decreased rather than increased. Table 3 presents the between-person correlation matrix.

Multilevel regression analyses

Nighttime alcohol consumption—Table 4 presents the results of the Nighttime alcohol consumption analysis. At level 1 (*within person*), nighttime alcohol consumption was regressed on daytime PTSD symptoms and the day of the week indicators. The PTSD slope did not have significant random variance and was thus fixed. Consistent with hypothesis, increased PTSD symptoms during the daytime were associated with subsequent greater levels of alcohol consumption that night. At level 2 (*between person*), nighttime alcohol consumption (i.e., the random intercept from the L1 model) was regressed on PTSD symptoms (subject mean across daytime assessments), PTSD symptoms were regressed on negative urgency, and negative urgency was regressed on emotional intelligence. The initial model included gender and age as demographic controls, however they were not associated with the outcome and hence dropped for parsimony. Consistent with hypothesis 3a, emotional intelligence was inversely associated with negative urgency. Consistent with hypothesis 4a, negative urgency was positively associated with PTSD symptoms. However, PTSD symptoms were not associated with alcohol consumption at Level 2 (*between person*). Hence, Hypothesis 5a was not supported.

We subsequently tested whether either urgency or emotional intelligence had direct effects on nighttime alcohol consumption that were not accounted for by the hypothesized fully mediated model. Emotional intelligence but not negative urgency exhibited a significant direct effect and hence this path was added to the model. We next tested the hypothesized cross-level interactions (Hypotheses 7a and 8a). Neither was significant (p 's $> .45$); consequently, neither was included in the final model.

Finally, we calculated the indirect effects of emotional intelligence and negative urgency on alcohol consumption (see Table 5). The hypothesized indirect effects of emotional intelligence (Hypothesis 3c) and negative urgency (Hypothesis 4b) on alcohol consumption were not supported. At level 1, $R^2 = .05$, $p < .001$, indicating the model accounted for a small but significant portion of the within-person variance in alcohol consumption. However, at Level 2, the model did not account for a significant amount of variance between-persons in alcohol consumption $R^2 = .11$, $p = .071$. The model did account for significant variance in both PTSD symptoms ($R^2 = .18$, $p = .011$) and negative urgency ($R^2 = .17$, $p = .009$).

Alcohol-related problems—Table 5 and Figure 1 present the results of the alcohol problems analysis. At level 1, nighttime alcohol problems were regressed on nighttime

alcohol consumption, daytime PTSD symptoms, and the day of the week indicators. Neither the nighttime alcohol consumption nor PTSD slope had significant variation and were thus fixed. Consistent with hypothesis 1b, increased PTSD symptoms during the daytime were associated with subsequent greater alcohol-related problems that night. As expected, there was a significant association between alcohol consumption and alcohol related problems (Hypothesis 2), supporting the criterion validity of the assessments. At level 2 (*between-person*), both mean PTSD symptoms (Hypothesis 5c) and alcohol consumption (Hypothesis 6) were significantly associated with alcohol-related problems. In addition, consistent with the above analysis, emotional intelligence had a significant direct effect on negative urgency and alcohol consumption and negative urgency had a significant effect on PTSD symptoms. We subsequently tested whether negative urgency or emotional intelligence had direct effects on problems. Neither was significant and they were not added to the model (p 's > .46). We subsequently tested hypothesized cross-level interactions. None were significant (p 's > .23) and hence not included in the final model (Hypotheses 7b and 8b).

Table 5 reports the indirect effects of emotional intelligence and urgency. Consistent with hypotheses, emotional intelligence was indirectly associated with PTSD symptoms (Hypothesis 3b) and alcohol problems (Hypothesis 3d) via negative urgency. Negative urgency was indirectly associated with alcohol problems via PTSD symptoms (Hypothesis 4c). The indirect effect of PTSD symptoms on alcohol problems via consumption (Hypothesis 5b) was not supported. The model accounted for a significant portion of variance between persons in negative urgency ($R^2 = .16$, $p = .025$), PTSD symptoms ($R^2 = .19$, $p = .008$), and alcohol problems ($R^2 = .39$, $p < .001$), but not alcohol consumption ($R^2 = .07$, $p = .100$)¹.

Discussion

The current study adds clear support to the literature regarding functional associations between PTSD symptoms and alcohol use and associated problems. Veterans drank more and experienced more alcohol-related problems on nights when they reported increased difficulty with PTSD symptoms during the day. The study also provides partial support for the hypothesized resilience and vulnerability factors of emotional intelligence and negative urgency, respectively. Emotional intelligence was inversely associated with PTSD symptoms, alcohol consumption, and alcohol related problems. These effects were predominantly indirect via decreased negative urgency. Negative urgency, in turn, was indirectly associated with greater alcohol consumption and problems via its positive association with PTSD symptoms. Although hypothesized direct and indirect between-person effects of emotional intelligence and negative urgency were supported, the hypothesized cross-level moderation effects were not.

PTSD symptoms and alcohol outcomes

Numerous lines of inquiry support a functional association between symptoms of PTSD and problematic alcohol consumption among veterans. This functional association is most

¹The R^2 values and coefficients for identical relationships in the alcohol consumption and problems analysis vary slightly due to the data imputation being done separately for each model.

commonly framed in respect to a self-medication model, whereby individuals increase their alcohol consumption in an attempt to alleviate painful symptoms (Leeies et al., 2010; Simpson et al., 2012). Indeed, the high comorbidity rates in conjunction with prospective associations between symptom onset and drinking problems (Shipherd, Stafford, Tanner, 2005; Simpson et al., 2012) and analog laboratory findings (Coffey et al., 2002) lend support to this model. However, relatively little research has been able to examine within-person associations between PTSD symptoms and drinking behavior in the natural environment utilizing ESM methods. Such methods provide an ideal approach to testing these theoretical associations. The current study adds to the small number of studies utilizing ESM or similar methods to examine PTSD and alcohol use, and, to our knowledge, is one of the first to examine this issue among OIF/OEF veterans.

In addition, the current study extends previous research to examine within-person associations between PTSD symptoms and both alcohol consumption and related problems. The observed within-person association between PTSD symptoms and alcohol consumption is consistent with a self-medication model; individuals increased drinking on nights following daytime symptom exacerbation. However, PTSD symptoms were also associated with increased alcohol problems above and beyond the effect of drinking level, and this was observed both within- and between- person. These findings suggest that the observed associations between PTSD and alcohol problems may not be accounted for self-medication. That is, veterans are reporting increases in alcohol-related problems associated with their PTSD symptoms that are not accounted for by their level of consumption. This is congruent with findings by Ouimette and colleagues (2010) who reported that weekly increases in PTSD symptoms in a treatment sample were more strongly associated with substance dependence symptoms rather than use. In addition, previous research on young adult samples indicates similar associations between negative affect and alcohol problems when controlling for drinking level (Simons et al., 2005; 2010).

PTSD is related to a variety of problems regulating emotion and behavior. Hence, difficulty regulating alcohol consumption, as well as behavior while intoxicated, may thus extend beyond self-medication. Individuals are not just drinking to alleviate symptoms, but are drinking while having substantial problems regulating themselves. This dysregulation results in increased risk for alcohol-related problems, beyond what may be accounted for by negatively reinforced elevations in consumption. At the within subjects level, this is evident in the direct effect of PTSD symptoms on problems over and above consumption level. At the between subjects level, whereas emotional intelligence, negative urgency, and PTSD symptoms exhibited significant associations with alcohol problems, the total effects on between-person differences in alcohol consumption were largely insignificant. That is, although emotional intelligence exhibited indirect effects on problems via alcohol consumption, neither PTSD symptoms nor negative urgency did. Hence, the effects of dysregulation on alcohol-problems are primarily not mediated via alcohol consumption at either the within or between subjects level. Thus, difficulties regulating emotion and behavior predict alcohol problems directly, rather than via contributing to increases in drinking level. Treatment models that address emotional regulation may contribute to improvements in alcohol problems irrespective of one's ability to reduce alcohol consumption levels.

Vulnerability and Resilience Factors

Emotional intelligence was associated with lower negative urgency and indirectly associated with fewer PTSD symptoms and less alcohol consumption and associated problems via this association, supporting its role as a resilience factor. In addition, there was a direct inverse association between emotional intelligence and alcohol consumption. The indirect associations of emotional intelligence via negative urgency are consistent with recent research on borderline personality symptoms (Gaher et al., 2013) and alcohol use (Shishido et al., 2012; Wray, Simons, Dvorak, Gaher, 2012).

We hypothesized that emotional intelligence and negative urgency would act in part by moderating the hypothesized within-person relationships. By definition, individuals who exhibit high levels of negative urgency are expected exhibit more “rash action” when negatively aroused. However, our data did not support this. Previous research using ESM in a young adult sample has supported increased associations between anxiety and alcohol consumption (Simons et al., 2010). The reason for this null finding is not clear.

We thus hypothesized that individuals characterized by greater emotional intelligence would be more effective in coping with PTSD symptom exacerbations, resulting in a weaker within-person association between symptoms and alcohol use and problems. However, as with negative urgency, the cross-level interaction was not supported. The inverse association between emotional intelligence and negative urgency is consistent with this line of reasoning; however, the cross-level interaction did not emerge. Emotional intelligence may have diffuse effects across time that is not captured by the sampling protocol (i.e., daytime symptoms predicting nighttime drinking behavior).

Limitations

The ESM methodology, veteran sample, and theoretical model are substantial strengths. However, there are also several related limitations that warrant attention. The sequencing of daytime symptoms predicting nighttime drinking behavior provides a relatively unambiguous direction of effects. However, the direction of relationships at the between subjects level is unclear, as the data is essentially cross-sectional. For example, Miller and colleagues (2006) found that disinhibition mediated the relationship between PTSD symptoms and substance use problems. This is in contrast to the model put forth here. However, the lack of additional direct relationships found in exploratory analyses is supportive of the hypothesized structure. However, PTSD symptoms, rather than negative urgency, exhibited direct relationships with alcohol problems. Nonetheless, additional research with prospective designs is needed to better explicate the associations between impulsivity, emotional intelligence, and PTSD in the context of alcohol use among veterans. Second, given the focus of the study on understanding alcohol related problems, a moderate to heavy drinking sample was recruited. The observed relationships may differ across a more representative population that spans from abstainers to individuals with severe dependence. Third, the sample of 90 individuals is relatively small for testing the cross-level interactions and two weeks of ESM data is a brief snapshot of behavior. None-the-less, this is an important step in this innovative area of research. Finally, a strength of ESM is reducing biases introduced by retrospective recall (Shiffman, 2009). However, there is

always risk of reactivity effects or reluctance to self-disclose. Our procedure tried to maximize honest reporting and limited research supports the accuracy and lack of reactivity of ESM data (Neal & Fromme, 2007; Wray et al., 2012).

Summary

In conclusion, the results indicate that day-to-day exacerbations in PTSD symptoms are associated with acute increases in drinking and associated problems. The association between symptoms and drinking is consistent with a self-medication model. However, the direct association between PTSD symptoms and alcohol related problems, above and beyond changes in drinking level, suggest a broader mechanism related to perturbations in self-regulation capacity. Emotional intelligence is associated with better ability to control behavior when emotionally aroused and greater resilience manifest in fewer PTSD symptoms, less alcohol consumption, and fewer alcohol problems.

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Figure 1. Alcohol problems analysis

Note. Unstandardized coefficients, $*p < .05$, $**p < .01$, $***p < .001$

Table 1

Descriptive statistics

	<i>M (SD)</i>	Range	Skew
PTSD symptoms *	1.87 (2.77)	0 – 17	2.10
Alcohol Consumption *	0.01 (0.89)	–0.63 – 3.81	1.68
Alcohol problems *	1.50 (2.72)	0 – 18	2.70
Negative urgency	1.70 (0.81)	0.36 – 4	0.50
Emotional intelligence	111 (16.37)	75 – 160	0.43
Age	28.90 (5.64)	20–50	1.43

Note. $N = 80 - 85$ for gender, age, emotional intelligence, and negative urgency variables. Gender: Men ($N = 54$), Women ($N = 28$).

* Indicates variables collected through ESM. Number of ESM assessments ranged between 1223 – 1272 for the within-person (Level 1) PTSD symptoms and drinking variables.

Table 2

Between-subject Correlations

Measure	1	2	3	4	5	6
1. Alcohol Consumption	-					
2. Alcohol problems	.43**	-				
3. Urgency	.13	.30**	-			
4. Emotional intelligence	-.29*	-.34**	-.41**	-		
5. PTSD symptoms	.12	.45***	.42**	-.25*	-	
6. Gender	-.21	-.11	.05	.17	.04	-
7. Age	-.23*	-.27*	-.15*	.28*	-.09	.31**

Note. N's range from 80 – 90.

*
p < .05
**
p < .01

p < .001

Gender is coded 1 = Women, 0 = Men; Age, Gender, Emotional Intelligence and Urgency are from the baseline survey; PTSD Symptoms, Alcohol Consumption, and Alcohol Problems are the subject means of the experience sampling data.

Table 3

Alcohol Consumption Analysis

Predictors	Outcomes							
	Alcohol Consumption				PTSD symptoms			
	<i>b</i>	<i>SE</i>	<i>p</i>		<i>b</i>	<i>SE</i>	<i>p</i>	
Intercept	0.01	0.05	.980	–0.02	0.21	.944	–0.04	0.08
PTSD symptoms	0.05	0.02	.002					
PTSD symptoms	0.01	0.03	.729					
Negative urgency				1.19	0.30	<.001		
Emotional intelligence	–0.08	0.03	.003				–0.20	0.04
Time Covariates								
Monday	0.09	0.09	.308					
Tuesday	0.03	0.07	.663					
Wednesday	0.20	0.09	.022					
Thursday	0.12	0.07	.096					
Friday	0.37	0.09	<.001					
Saturday	0.44	0.09	<.001					

Note. Within person (Level 1) *N* = 1364; Within-person effects are bold font. Between person (Level 2) *N* = 90. Between-person effects are regular font. All coefficients are unstandardized.

Table 4

Alcohol problems analysis

Predictors	Outcomes											
	Alcohol Problems				Alcohol Consumption				PTSD symptoms			
	<i>b</i>	<i>SE</i>	<i>p</i>		<i>b</i>	<i>SE</i>	<i>p</i>		<i>b</i>	<i>SE</i>	<i>p</i>	Negative urgency
Intercept	-1.70	0.13	<.001		-0.02	0.04	.725		-0.02	0.21	.933	-0.04 0.08 .658
Alcohol Consumption	0.78	0.07	<.001									
PTSD symptoms	0.05	0.02	.013									
Alcohol Consumption	1.03	0.26	<.001									
PTSD symptoms	0.26	0.05	<.001		0.01	0.03	.666					
Negative urgency								1.21	0.29	<.001		
Emotional intelligence					-0.07	0.03	.007					-0.20 0.04 <.001
Time Covariates												
Monday	-0.13	0.15	.404									
Tuesday	-0.02	0.15	.910									
Wednesday	-0.21	0.15	.158									
Thursday	-0.22	0.15	.145									
Friday	-0.27	0.14	.059									
Saturday	-0.10	0.17	.540									

Note. Within-person (Level 1) *N* = 1364. Within-person effects are bold font. Between-person (Level 2) *N* = 90. Between-person effects are regular font. All coefficients are unstandardized.

Table 5

Indirect effects

Hypothesis	Predictor	Mediator(s)	Outcome	Indirect effect
3b	Emotional intelligence	NU	PTSD symptoms	-0.24, $p = .003$
3c	Emotional intelligence	NU->PTSD sxs	Alcohol consumption	-0.00, $p = .727$
3d	Emotional intelligence	NU -> PTSD sxs NU->PTSD sxs -> Alcohol consumption	Alcohol problems	-0.07, $p = .004$
Exploratory	Emotional intelligence	Alcohol consumption	Alcohol problems	-0.07, $p = .038$
4b	Negative urgency	PTSD sxs	Alcohol consumption	0.01, $p = .725$
4c	Negative urgency	PTSD symptoms	Alcohol problems	0.34, $p < .001$
5c	PTSD sxs	Alcohol consumption	Alcohol problems	0.01, $p = .660$

Note. NU = negative urgency, sxs = symptoms.