

3-2014

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## Scholar Commons Citation

Cohn, Amy; Hagman, Brett T.; Moore, Kathleen A.; Mitchell, Jessica; and Ehlke, Sarah, "Does Negative Affect Mediate the Relationship Between Daily PTSD Symptoms and Daily Alcohol Involvement in Female Rape Victims? Evidence from 14 Days of Interactive Voice Response Assessment" (2014). *Mental Health Law & Policy Faculty Publications*. 828.

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Published in final edited form as:

*Psychol Addict Behav.* 2014 March ; 28(1): 114–126. doi:10.1037/a0035725.

## Does negative affect mediate the relationship between daily PTSD symptoms and daily alcohol involvement in female rape victims? Evidence from 14 days of interactive voice response assessment

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### Abstract

The negative reinforcement model of addiction posits that individuals may use alcohol to reduce with negative affective (NA) distress. The current study investigated the mediating effect of daily NA on the relationship between daily PTSD symptoms and same-day and next-day alcohol involvement (consumption and desire to drink) in a sample of 54 non-treatment-seeking female rape victims who completed 14 days of interactive voice response assessment. The moderating effect of lifetime alcohol use disorder diagnosis (AUD) on daily relationships was also examined. Multilevel models suggested that NA mediated the relationship between PTSD and same-day, but not next-day alcohol involvement. NA was greater on days characterized by more severe PTSD symptoms, and alcohol consumption and desire to drink were greater on days characterized by higher NA. Further, daily PTSD symptoms and NA were more strongly associated with same-day (but not next-day) alcohol consumption and desire to drink for women with an AUD than without. Results suggest that NA plays an important role in female rape victims' daily alcohol use. Differences between women with and without an AUD indicate the need for treatment matching to sub-types of female rape victims.

### Keywords

Rape; Alcohol; Interactive Voice Response; Daily Diary; PTSD; Negative Affect

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Epidemiological data indicate that the lifetime prevalence of rape and sexual assault is approximately 12–18%, (Kilpatrick, 2007; Kilpatrick, Edmunds, & Seymour, 1992; Tjaden & Thoennes, 2006). Nearly a quarter of rape victims will develop post-traumatic stress disorder (PTSD), and many exhibit sub-threshold symptoms of PTSD (Kilpatrick, 2007; Ullman, Filipas, Townsend, & Starzynski, 2007). Alcohol involvement and alcohol use disorders (AUDs), which have a high degree of co-occurrence with PTSD, also show

complex relationships to rape and sexual assault as both risk factors and consequences (Testa, Hoffman, & Livingston, 2010). A substantial body of literature has established that alcohol use inhibits post-assault recovery and is a major barrier to post-rape service utilization, police reporting, and help-seeking (Amstadter et al 2008; Wolitzky-Taylor et al 2012). Understanding the specific mechanisms that maintain problem drinking in relation to PTSD symptoms among female rape victims has been relatively overlooked in the extant literature.

According to the negative reinforcement model of addiction (Baker, Piper, McCarthy, Majeskie, & Fiore, 2004), alcohol use is maintained by the desire to alleviate or avoid emotional distress. Thus, some women who have experienced a rape may drink as a way to regulate emotions in response to aversive internal experiences, perhaps those that arise from symptoms of post-traumatic stress, such as intrusive thoughts, hyper-arousal, and hyper-vigilance, which can cause emotional distress (Mueser, Rosenberg, Goodman, & Trumbetta, 2002). However, application of the negative reinforcement model of addiction to explain drinking behavior among female rape victims has been untenable due to inconsistent findings in the literature. Some cross-sectional and longitudinal studies suggest strong positive associations between sexual assault related PTSD symptoms and alcohol consumption (Grayson & Nolen-Hoeksema, 2005; Kaysen et al., 2011; Kaysen et al., 2007; Rosenthal, Cheavens, Lejuez, & Lynch, 2005; Shipherd & Beck, 1999; Stewart, 1996; Ullman, Filipas, Townsend, & Starzynski, 2005, 2006). Further, a few compelling prospective studies support the assertion that alcohol use develops and is maintained in response to PTSD symptoms (Epstein, Saunders, Kilpatrick, & Resnick, 1998) (Back et al 2006). However, some recent longitudinal studies have failed to find a relationship between sexual assault related PTSD and alcohol use (Najdowski & Ullman, 2009; Testa, Livingston, & Hoffman, 2007; Walsh et al., 2012), suggesting that other factors that impact the relationship between PTSD and alcohol use should be examined.

Negative affect (NA) is one important aspect of the negative reinforcement model that may help reveal the circumstances under which female rape victims may be more or less likely to drink in response to PTSD symptoms. In general, people drink more and report an increased desire to drink on days characterized by greater NA (DeHart, Tennen, Armeli, Todd, & Affleck, 2008; Swendsen et al., 2000). NA has also been shown to predict subsequent alcohol cravings (M. Litt, Cooney, & Morse, 2000; Oslin, Cary, Slaymaker, Colleran, & Blow, 2009), greater alcohol problems (Simons, Gaher, Oliver, Bush, & Palmer, 2005), and differentiates between individuals with and without an AUD (Carpenter & Hasin, 1999; Holahan et al, 2001). Traumatic experiences, such as rape, can also cause impairments in how one responds to NA (Beckham, Calhoun, Michael Glenn, & Barefoot, 2002; Khantzian, 1997; Mueser et al., 2002), perhaps intensifying the association between NA and drinking behavior. Intensity of PTSD symptoms following a traumatic event has been shown to predict increases in NA over time (Orth, Cahill, Foa, & Maercker, 2008; Yehuda, McFarlane, & Shalev, 1998). Further, "drinking to cope with NA" expectancies among female rape victims are related to problem drinking behavior (Mueser et al., 2002; Norman, Tate, Anderson, & Brown, 2007) and tension-reduction expectancies (in line with the negative reinforcement model) have been shown to be better predictors of alcohol use in adult rape victims than PTSD symptoms (Ullman, Fillipas, Townsend, Starzynski, 2005).

While the former lines of research suggest that NA co-occurs with alcohol use and post-traumatic stress symptoms, the degree of association is not clearly defined. Some studies show that some, but not all types of NA predict subsequent drinking behavior (Hussong, Levy, & Curran, 2001; Swendsen et al., 2003). These inconsistencies in the literature suggest important gaps and research questions that need to be resolved.

A few experimental studies have focused on understanding the role of alcohol and drug use in the context of PTSD symptoms using “in vivo” laboratory paradigms (Coffey, Stasiewicz, Hughes, & Brimo, 2006; Coffey et al., 2002; Saladin et al., 2003). Coffey et al (2002), for example, found that personalized trauma cues prompted craving for alcohol or cocaine in alcohol or cocaine dependent individuals, respectively. In a follow-up study using the same sample, Saladin et al (2003) found that participants with more severe PTSD symptoms had stronger substance use cravings after hearing a personalized trauma-relevant vignette and seeing a relevant drug-related in vivo cue. Finally, Coffey and colleagues (2006) found that AUD diagnosed participants who were randomized to six sessions of trauma-focused imaginal exposure, as opposed to six sessions of relaxation, showed decreases in emotional distress and cue-induced alcohol craving over time. The authors hypothesized that participants in the exposure condition became habituated to, and eventually extinguished NA elicited by re-experiencing the traumatic event, which may have led to overall decreased desire to drink. Although results of these studies are promising in parsing out the associations among PTSD symptoms, emotional distress, and alcohol use, it is important to note that the dependent variable measured in all of these studies was craving for alcohol, not actual consumption. An assessment of how PTSD symptoms and NA impact actual drinking behavior, in a causal and “real time” manner, is needed. Further, the study samples described above included sexual and non-sexual assault victims, they did not focus explicitly on rape victims, who have been shown to have their own unique set of risk factors and post-trauma consequences relative to victims of other types of traumatic events (Brewin, Andrews, & Valentine, 2000; Ozer, Best, Lipsey, & Weiss, 2003).

Where longitudinal and experimental studies capture one aspect of the relationships among PTSD, NA, and drinking, daily electronic reporting is an innovative assessment technique that would allow us to examine how NA, PTSD symptoms, and drinking unfold in a day-to-day manner and in one’s natural environment. First, daily assessment allows for more frequent observations of behavior “in or near-real-time”. It therefore provides greater ecological validity than traditional paper-and-pencil formats or laboratory paradigms, and enhances measurement reliability by substantially increasing the number of data points one has to predict an outcome of interest (Bolger, Davis, & Rafaeli, 2003; Collins et al., 1998; Neal et al., 2006; S Shiffman, 2000; S. Shiffman, 2009). Daily reporting methods also minimize recall biases inherent in traditional paper-and-pencil designs, which often rely on retrospective self-reports of behavior. Second, electronic forms of daily reporting can be “time-stamped” such that behavior can be recorded with high precision, sometimes at a specific point in time, and relative to other behaviors. Third, the majority of studies that have examined causal associations among alcohol use and PTSD have used macro-longitudinal assessments, which are prospective studies conducted over extended periods of time (weeks, months, or years) (Banks et al., 2010; Barta & Tennen, 2008; Conner, Tennen, Fleeson, & Barrett, 2009; Moskowitz & Young, 2006). These are advantageous at providing

“snap shots” of behavior across groups or clusters of individuals, but they do not characterize the naturally occurring events surrounding behavior with sufficient individual-level detail and day-to-day variability associated with the dynamics of drinking behavior (Banks et al., 2010). Fourth, research shows limited correspondence between retrospective questionnaire reports of stress-motivated behavior (e.g., smoking, drug, alcohol use) and daily prospective reports of the same (M. D. Litt, Cooney, & Morse, 1998; J. Schwartz & Stone, 1998; J. E. Schwartz, Neale, Marco, Shiffman, & Stone, 1999; Stone et al., 1998; Todd et al., 2005). Thus, daily prospective electronic reports may provide insight into new constructs that explain why female rape victims, which are not currently measured through traditional paper-and-pencil assessments.

Only one study to our knowledge has used daily electronic assessments to examine the self-medication hypothesis for alcohol use behavior in a trauma-exposed sample. Simpson et al (2012) used daily Interactive Voice Response (IVR) technology to examine the relationships between PTSD symptoms and alcohol craving in a sample of 29 alcohol treatment-seeking men and women who reported experiencing or witnessing a traumatic event at some point in their life. Results from their study showed that daily PTSD symptom severity (a conglomeration of 7 symptoms) and specific PTSD symptoms (startle response, anger/irritability) predicted same-day and next-day alcohol craving. The reciprocal effect of alcohol craving predicting next day PTSD symptoms was not significant.

Limitations of the Simpson et al (2012) study suggest more research is needed. First, and similar to the laboratory paradigms discussed above, Simpson et al (2012) measured craving to drink, not alcohol consumption. Second, Simpson et al (2012) used a sample of mostly male veterans and their findings may not generalize to adult women who have been raped. Studies show that rape victims differ from combat veterans, and that males differ from females in terms of trauma-related risks and consequences (Brewin et al., 2000; Ozer et al., 2003). Finally, Simpson et al (2012) used a sample of individuals seeking treatment for an AUD. Findings *generally* from help-seeking individuals with PTSD and AUD might not translate to non-help seeking populations (Amstadter, McCauley, Ruggiero, Resnick, & Kilpatrick, 2008; Kilpatrick, 2007).

## Study Aims and Hypotheses

Taken together, a body of research suggests that daily NA would mediate the relationship between daily PTSD symptoms and daily alcohol consumption and desire to drink in women who have been raped, however this has never been examined. Additionally, we would expect that alcohol problem severity, such as having an alcohol use disorder (AUD) diagnosis, would amplify the extent to which daily PTSD symptoms and NA relate to daily alcohol involvement. In the present study, we used 14 days of IVR assessment to examine the day-to-day variability in alcohol consumption and desire to drink, NA intensity, and PTSD symptomatology in a sample of non-treatment-seeking female rape victims with and without an AUD. Our first aim was to examine whether daily NA mediates the association between daily PTSD symptom severity and alcohol involvement (alcohol consumption or desire to drink) on the same-day and on the next day. We predicted that NA would be more intense on days characterized by greater PTSD symptomatology, and that alcohol

consumption and desire to drink would be greater on days characterized by more intense NA and greater following days of intense NA. Our second aim was to examine the moderating effect of AUD diagnosis on associations among PTSD, NA, and alcohol involvement. We predicted that PTSD and same-day NA would be more strongly correlated with each other in women with an AUD than women without an AUD. We also predicted that, among women with an AUD, both PTSD symptoms and NA would be more strongly correlated with alcohol involvement (same-day and next-day) than among women with no AUD.

## Method

### Participants

This report is based on data collected from 60 women who participated in a larger prospective study designed to examine the impact of daily life factors on the 6-month help-seeking and mental health outcomes of female rape victims. Participants were recruited through word-of-mouth, print and web-media, and respondent-driven sampling. Advertisements asked for women who had experienced an unwanted sexual incident and who were not in treatment.<sup>1</sup>

Women were eligible for inclusion in the study if they were (1) between the ages of 18 and 65; (2) able to provide names and contact information for two locator persons; (3) reported a rape in the past 5 years; and (4) not currently (past 12- months) in treatment for mental health or substance use problems. Rape was defined as penetration of the woman's vagina, mouth, or anus without consent, a definition used in prior population-based studies to measure rape experiences in women (Kilpatrick et al., 2007).<sup>2</sup> Participants were excluded for severe current psychiatric disturbance (suicidal or homicidal intent with plan); current use of either heroin, opiates (oxycodone), crack, or cocaine > 6 days per week in the past month (indicative of physiological dependence); or if they were currently pregnant or planning to become pregnant in the next 6 months (so as not to incentivize the use of alcohol during pregnancy).<sup>3</sup>

Of the 60 participants who were enrolled, 6 did not complete any daily monitoring. Thus, analyses below were based on 54 women (90% of the sample) who provided one or more data points on the IVR system.<sup>4</sup> There were no differences between women who did or did not complete any daily monitoring on demographic or other baseline factors (alcohol use, PTSD symptomatology, and AUD diagnosis). Approximately 60% of the 54 participants

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<sup>1</sup>Because some women do not acknowledge an unwanted sexual incident as a rape, we included behaviorally specific questions in our screening to query for rape, rather than ask directly.

<sup>2</sup>We chose the same definition of treatment used in prior studies (Sobell et al., 2002; Sobell, Sobell, Toneatto, & Leo, 1993; Weisner & Matzger, 2002): any court- or employer-mandated or self-referred intervention received by an individual at a formally recognized program or licensed or license-eligible treatment provider for more than two sessions, attendance at > 2 Alcoholic Anonymous or other mutual self-help group meetings, or any prescribed medication. Prior treatment did not include advice/feedback given by friends, family, coworkers, physicians, medical personnel, or clergy about alcohol problems or detoxification without treatment.

<sup>3</sup>Per requests of the IRB, we excluded participants with active suicidal or homicidal features, or whose stimulant or opiate use represented an immediate health hazard, because the proposed study design did not address or treat these symptoms and had the potential to place the participant at greater risk for medical and psychological problems relative to the benefits of participation. Since the primary aim of this study was to examine the longitudinal help-seeking outcomes of untreated female rape victims, these individuals were given referrals for treatment, but were no longer considered eligible for the study. We considered the impact of excluding these people on the overall science of the project, but felt it was more important to provide referrals for treatment than to observe these individuals potentially decline or decompensate in their mental health or alcohol use over the course of the study without intervening.

were recruited via flyers/brochures posted in the community (n = 16) or via ads on Craigslist (n = 18); 24% (n = 13) through “other” means (presentations to local community partners and University student groups about the study); and 10% (n = 7) through personal or professional referrals. Women were in their mid-twenties (mean age = 26; SD = 9.08; Range 18–56), primarily single (n = 34; 60%), had completed at least some college or post-high school education (n = 38; 70%), and reported a median household income of \$9,000 (SD = 20,032). Forty one percent were students (n = 22), 32% (n = 17) were unemployed, and 25% were employed full or part-time (n = 15). In terms of racial/ethnic background, 70% (n = 38) were White, 9% (n = 5) Black or African-American, 4% (n = 2) Asian, 4% (n = 2) Native American, and 13% (n = 7) labeled themselves as “other”. In terms of lifetime treatment history, only 6% (n = 3) had been in any type of professional treatment related to alcohol or drug use in their lifetime and 9% (n = 5) had attended an AA or other self-help meeting for their own alcohol or drug use in their lifetime.

## Measures

**Alcohol Consumption**—*The Timeline Follow Back Interview* (TLFB; Sobell & Sobell, 1996) was used to assess women’s percent heavy days drinking (4 or more drinks/day) and mean drinks per drinking day in the 90-days prior to the baseline interview. The TLFB has demonstrated good test-retest reliability and psychometric properties for 90-day aided recall periods of drinking (Maisto, Sobell, Cooper, & Sobell, 1982; Maisto, Sobell, & Sobell, 1982).

**Alcohol Use Disorder Diagnoses**—*The Structured Clinical Interview for DSM-IV* (SCID; First, Gibbon, Spitzer, & Williams, 1996) was used to determine lifetime and current diagnoses for alcohol abuse and dependence. SCID interviews were administered by trained master and doctoral level students who met weekly with the principal investigator. All cases were reviewed by the principal investigator.

**Post-Traumatic Stress Disorder Symptomatology**—*The Posttraumatic Stress Disorder Symptom Checklist, Civilian Version* (PCL-C; Blanchard et al., 1996) is a 17-item self-report questionnaire that was used to assess women’s experiences of PTSD symptoms in the month prior to the baseline assessment. Participants were asked to rate the extent to which they were bothered by certain problems or complaints following a stressful life event. Responses were measured on a 5-point Likert scale, ranging from 1 “Not at all” to 5 “Extremely.” The PCL-C has demonstrated good reliability and convergent validity with DSM-IV diagnoses of PTSD (Freedy et al., 2010; National Center for PTSD, 2013) and shows a high correlation with the Clinician Administered PTSD Scale (CAPS) at  $r = .93$  (Blanchard et al., 1996; Weathers & Ford, 1996). The PCL-C can be scored to yield a measurement of overall symptom severity by summing all items together, or a DSM-IV derived PTSD diagnosis (National Center for PTSD). Diagnoses are obtained by adding

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<sup>4</sup>Sample size projections were based on small to moderate effect sizes from prior cross-sectional (Kaysen et al., 2007; Ullman et al., 2005), meta-analytic (Orth & Wieland, 2006), macro-longitudinal (Kaysen et al., 2011), and daily diary studies (Paige Ouimette, Read, Wade, & Tirone, 2010; Simons et al., 2005; Simpson et al., 2012) (between the predictors of interest (PTSD symptoms, NA) on various alcohol use outcomes. The sample inclusion criteria and assessment method in these papers are different from those detailed in this paper.

together responses to at least one item from questions 1 through 5 (“B” criteria), three items from questions 6 through 12 (“C” criteria), and at least 2 items from questions 13 through 17 (“D” criteria). Symptoms rated as “moderately” or above (response options of 3 or higher) are counted as being present to determine criteria included in the diagnosis. The symptom-cluster method of score demonstrates a high degree of diagnostic accuracy (comparable to the cut-score approach) in relation to CAPS and DSM-IV PTSD diagnoses (Blanchard et al., 1996; McDonald & Calhoun, 2010; Ruggiero, Del Ben, Scotti, & Rabalais, 2003).

**IVR Assessments**—Daily factors were measured in the following domains: alcohol use, desire to drink, NA, and PTSD symptoms. Alcohol use was measured by summing together the quantity of consuming beer, wine, and liquor in standard drink conversions reported on one given date. Responses were recorded to obtain measurements of drinking that occurred on the day of the phone call (today) and after the IVR call of the previous day (last night). This allowed us to capture any drinking that may have occurred after the previous evening’s phone call, but before the participant went to bed. Desire to drink was measured by asking participants to “rate how strong your thoughts were of drinking today,” with response options ranging from 0 “not at all strong” to 4 “extremely strong.” NA was measured by asking participants to rate the intensity of feeling sad, nervous, tense, angry, and lonely “today” on a 5-point scale ranging from 0 “not at all” to 4 “extremely”. Items were adapted from existing measurements of mood and have been validated in several previous daily diary studies (Larsen & Diener, 1992; D. Watson, Clark, & Tellegen, 1988). An average NA score was calculated for each day by taking the sum of the items and dividing them by the number of items. PTSD symptoms were assessed via an abbreviated version of the PCL-C, which used a dichotomous scoring scheme of 1 “yes” or 0 “no” for each item. We replaced the term “stressful experience” with “unwanted sexual experience” to anchor responses to sexual trauma. To reduce participant burden and to keep the survey brief, seven items were chosen from the PCL-C based on expert consultation and selecting items that demonstrated the highest diagnostic efficiency and strongest correlation with the total score of the CAPS (Blanchard et al., 1996). The seven items captured avoidance of reminders of the traumatic event, feeling distant from others, sleep disturbance, nightmares about the event, feeling upset by reminders of the event, experiencing physical reactions to reminders of the event, and loss of pleasure. Scale instructions were modified to fit the assessment time frame (the last 24 hours). The frequency of “yes” responses were summed together to create an overall composite score of PTSD symptom severity. Aggregate daily responses on PTSD symptom severity were significantly correlated with baseline PCL-C total scores ( $r = .54, p < .001$ ) and current PCL-C derived PTSD diagnosis ( $r = .44, p < .001$ ); suggesting adequate construct validity. The daily measures have established psychometric properties based on the empirical literature and previous daily diary studies (S Armeli, Tennen, Affleck, & Kranzler, 2000; Mundt, Bohn, King, & Hartley, 2002; Mundt, Searles, Perrine, & Walter, 1997; Simpson et al., 2012).<sup>5</sup>

**Procedure**—After completing a telephone screen to determine eligibility, individuals were invited to a 2 hour baseline assessment to confirm eligibility. At the baseline, they provided informed consent, completed the baseline questionnaires, semi-structured interviews, and then 20-minutes of training on the IVR and were provided a hard copy of the questions and

response options administered by the IVR system at the conclusion of the training. Participants were instructed to being IVR monitoring on the following day. Participants received \$25 for the baseline assessment.

**IVR Procedure and Monetary Incentives**—For 14 days following the baseline, participants recorded daily alcohol use, NA, and PTSD symptoms once a day during a six hour window in the evening from 6pm and 12am. IVR interviews took an average of 6 minutes to complete and were date- and time-stamped, and recorded immediately. Several system features were included to promote adherence, including clear prompts, minimal skip outs, and ability to return to and repeat questions. Reminder phone calls were given to participants by research staff if at least one full day of recording was missed. There were several incidents in which the IVR system turned off, due to power outages, and every effort was made by research staff to obtain missed data by reconstructing events in an in-person phone call.

To promote IVR compliance, we used a payment method consistent with “best practices” (Helzer, Badger, Searles, Rose, & Mongeon, 2006). Participants were paid a flat rate of \$15 for each week they made at least one call to the IVR systems. Additional bonus earnings included \$1 each time they provided complete data on the IVR (totaling up to \$7 a week); \$2 if they completed all phone calls for six of seven days or \$5 if they completed all phone calls for all 7 days of the week. Overall, participants were eligible to receive a total of \$54 if they complied with all IVR reports over the two week period.

All procedures were approved by the University IRB.

## Results

### Sample characteristics

**Baseline PTSD symptom severity and alcohol involvement**—Average scores on the PCL-C indicated that the sample fell in the moderate range of PTSD symptom severity ( $M = 44.57$ ;  $SD = 15.30$ ; range 17–73), and 50% ( $n = 27$ ) of the women received a PTSD

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<sup>5</sup>There has been a great deal of debate in the literature about the degree of potential overlap between PTSD symptoms and negative affect. While some theory suggests [tripartite model proposed by Clark & Watson, 1991] that a more universal vulnerability toward negative affective disturbance may contribute to the development of affective disorders, such as PTSD (Brown, Chorpita, & Barlow, 1998). Others suggest there are important distinctions between PTSD symptoms and negative affect (Watson, 2009; Kashdan et al., 2006). Mineka et al (1998) proposed a hierarchical model in which anxiety (and mood) disorders were hypothesized to share a common factor of negative affectivity, but were also comprised of unique elements at the syndromal level not shared by the common factor. For example, not all symptoms of PTSD capture negative affect (David Watson, 2009), like loss of interest in pleasant activities, and some symptoms capture the absence of negative emotionality, such as emotional numbing and dissociation (APA, 2000). Empirically, Bradley et al (2011) found that a general tendency toward emotional dysregulation more strongly predicted PTSD symptoms than negative affect; while Zoellner, Goodwin, and Foa (2000) found that PTSD symptoms predicted physical health complaints beyond the general effects of negative affect. These studies, taken together, suggest that negative affect and PTSD are incrementally valid over each other, and show unique associations to correlates of traumatic stress. Lastly, a further distinction between PTSD symptoms and NA can be found in the methodology of the present study: our assessment of daily NA and PTSD symptoms showed very little item-level content overlap and only a weak within-person association using HLM ( $b = .13$ ,  $p < .05$ ). Additionally, the daily NA items assessed feelings of sadness, nervousness, anger, loneliness, and tension. Daily PTSD items were worded as follows: “avoiding people, places or things?”, “felt distant or cut off from others?”, “trouble falling asleep or staying asleep?”, “disturbing nightmares about the event?”, “have physical reactions (racing heart, sweating) when something reminded you of the event?”, “feeling very upset when something reminded you of the event?”, “loss of interest or pleasure in activities?”. The only item from the NA assessment that could potentially overlap with PTSD symptoms was the assessment of anger, but we did not measure anger as part of our daily measurement of PTSD symptoms.

diagnosis (based on PCL-C derived cut-off scores). Baseline reports of drinking from the TLFB showed that women consumed an average of 4 standard drinks on the days that they drank ( $SD = 3.18$ ; range 0–14) and reportedly drank heavily on 8% of those days ( $SD = 0.12$ ; range 0 – 0.60). Sixty-one percent of the sample ( $n = 33$ ) had a lifetime AUD diagnosis and 45% ( $n = 15$ ) had a current (past month) AUD diagnosis. Women with and without a lifetime AUD diagnosis did not differ significantly across baseline PTSD symptom severity, probability of a PTSD diagnosis, or on any demographic factors (age, race, education, income, employment). Not expectedly, women with a lifetime AUD had higher mean drinks per drinking day ( $M = 5.01$ ;  $SD = 3.12$ ) compared to women with no lifetime AUD [ $(M = 2.01$ ;  $SD = 2.34$ )  $F(1, 53) = 14.26, p < .01$ ], as well as significantly higher percent heavy drinking days ( $M = 12\%$ ;  $SD = 13$ ) compared to women with no AUD [ $(M = 2\%$ ;  $SD = 4$ ),  $F(1, 53) = 11.56, p < .001$ ].

**Daily alcohol use, PTSD symptom severity, and NA intensity**—On average, participants provided IVR responses on 73% of the reporting days (10 out of 13), with a modal IVR response rate of 93%. Drinking data were missing for 15% ( $n = 129$ ) of the total possible days ( $n = 756$ ). Baseline PCL-C severity scores were positively predictive of missed drinking data on the IVR, although this effect was quite small ( $b = 0.05, p < .02$ ). No other study variables or demographic factors were significantly related to missed drinking data on the IVR.

Participants consumed alcohol on approximately 26% of the days reported and experienced cravings for alcohol on 24% of the days reported. At the aggregate level, women with an AUD consumed 2.5 standard drinks per IVR reporting day ( $SD = 2.63$ ; range 0–9.4), whereas women without an AUD consumed less than one standard drink per reporting day ( $M = 0.25, SD = 0.38$ ),  $F(1, 53) = 14.86, p < .05$ . Also at the aggregate level, women with an AUD reported more intense daily urges to drink ( $M = 1.40, SD = 1.13$ ) compared to women with no AUD ( $M = 0.23, SD = 0.31$ ),  $F(1, 53) = 21.15, p < .05$ . Drinking was most likely to occur on Saturday (63%) and least likely to occur on Tuesday (26%), and desire to drink was strongest on Tuesday ( $M = 1.12, SD = 0.99$ ) and weakest on Sunday ( $M = 0.77, SD = 0.85$ ). Aggregate reports of NA ratings (averaged over the 14 days) were 0.93 ( $SD = 0.93$ ; range 0–4); with NA being greatest on Tuesday (Mean = 1.12;  $SD = 0.99$ ) and weakest on Sunday (Mean = 0.77;  $SD = 0.85$ ). Women experienced at least one PTSD symptom on 60% of the IVR reporting days and reported an average of 2.2 symptoms per day ( $SD = 2$ ; range 0–7). PTSD symptoms were greatest on Thursday (Mean = 2;  $SD = 2.18$ ) and weakest on Sunday (Mean = 1.30;  $SD = 2.13$ ).

**Correlations among study variables**—Table 1 displays descriptive statistics and correlations among baseline and aggregate daily variables (mean levels averaged over the course of 14 days). As can be seen, baseline alcohol consumption and AUD diagnosis had no significant associations with aggregate daily PTSD symptoms or reports of NA. Aggregate daily alcohol consumption was significantly correlated with aggregate daily NA, but not aggregate daily PTSD symptoms; aggregate daily desire to drink was significantly correlated with all variables, except baseline PTSD symptom severity. Lastly, with the

exception of daily desire to drink, baseline PTSD symptom severity was significantly and positively correlated with all daily factors to a moderate or high degree.

### **Within-person associations among daily PTSD symptoms, NA, and alcohol involvement**

**—Multilevel models with HLM software (V7; Raudenbush et al., 2004) were used to examine associations among daily factors and the impact of between-person factors (lifetime AUD diagnosis<sup>6</sup>). The data collected in this study form a hierarchical structure with 2 levels: days represent level-1 units nested within participants as the level-2 units. Therefore, variables assessed on a daily basis represent within-person variables and variables assessed once at baseline represent between-person variables. Following previous recommendations (Bryk & Raudenbush, 1992; Kreft & De Leeuw, 1998; Raudenbush & Bryk, 2002), we person-centered all within-subject variables. Because alcohol consumption is a count variable, we specified a Poisson model with a log-link function for models that used this as the outcome (Bryk & Raudenbush, 1992). Based on previous studies indicating a weekly cyclical component to drinking behavior (S Armeli et al., 2000; S. Armeli et al., 2003; S Armeli, Todd, Conner, & Tennen, 2008; Hussong, Hicks, Levy, & Curran, 2001; Simpson et al., 2012), we also controlled for day of the week in models that included daily alcohol consumption or desire to drink as the dependent variable by including six day-of-the-week orthogonal codes (Sunday = 1). Models that examined next-day consumption and desire to drink as the outcomes controlled for those same factors reported on the previous day.**

**Aim 1: Mediation Modeling**—We used an approach similar to Armeli et al (2000) to examine whether NA intensity mediated the association between daily PTSD symptoms and same-day and next-day alcohol involvement (consumption and desire to drink). Mediation was established by the identification of a significant coefficient from daily PTSD symptoms (predictor) to same-day NA (mediator) and from daily PTSD symptoms to alcohol consumption or desire to drink (same-day or next-day), as well as from NA to same-day and next-day alcohol consumption and desire to drink. According to MacKinnon et al. (2002), mediation may occur even if there is no direct path from the predictor to the outcome variable (D. P. MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002). Thus, direct effects of PTSD on same-day or next-day alcohol involvement were not necessary to determine mediation.

Figure 1 displays the results of mediation testing. In the first step of mediation testing, daily PTSD symptoms were positively and significantly associated with same-day NA intensity ( $b = .13, p < .00$ ). The within-person associations of daily PTSD symptoms to same-day alcohol consumption ( $b = -.01, p = .82$ ) and desire to drink ( $b = .03, p = .38$ ) were both non-significant; as were the within-person associations of daily PTSD symptoms to next-day alcohol consumption ( $b = .03, p = .16$ ) and next-day desire to drink ( $b = .05, p = .15$ ) after including relevant covariates. In the next step of mediation testing, multi-level models

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<sup>6</sup>We considered examining differences between women with a lifetime versus current AUD diagnosis on daily within-person relationships; or between women with a current AUD versus no AUD. However, given that only 28% of the sample had a current AUD diagnosis, we did not want to significantly reduce the sample size (or create uneven sample sizes), and thus our power to detect a cross-level interaction.

showed significant positive associations of NA intensity to same-day alcohol consumption ( $b = .12, p < .01$ ) and desire to drink ( $b = .40, p < .01$ ); although associations to next-day alcohol consumption ( $b = .04, p = .35$ ) and desire to drink ( $b = -.09, p = .25$ ) were both non-significant, after including relevant covariates.<sup>7</sup>

While results suggest that NA mediates the link between daily PTSD symptoms and daily alcohol involvement, no direct effect was evidenced.<sup>8</sup> To evaluate the extent to which daily PTSD symptoms relate to NA (a path) and the extent to which NA relates to the daily alcohol involvement (the b path), we examined the significance of the product of the a\*b path (Krull & MacKinnon, 2001). A test of the indirect effect (a\*b path) was significant (test statistic = 2.26,  $p < .05$ ), suggesting the presence of mediation.

**Aim 2: Moderating impact of AUD diagnosis on associations among daily factors**—Consistent with the extant literature (Ouimette, Read, Wade, Tirone, 2010; Ullman et al., 2006), we hypothesized that PTSD and NA would be more strongly linked to each other, and to alcohol involvement for women more vulnerable to drinking problems than those who are less vulnerable to alcohol problems. Therefore, in the next set of analyses, we examined whether AUD diagnosis moderated the daily co-variation between (a) PTSD symptoms and NA intensity, (b) PTSD symptoms and alcohol involvement (same-day and next-day), and (c) NA intensity and alcohol involvement (same-day and next day).

Table 2 provides results of the coefficients for the multi-level models of the cross-level interaction of PTSD x AUD predicting same-day NA intensity, which was significant. Specifically, the association between NA and PTSD was positive and stronger for women without an AUD than with an AUD. Table 3 presents results for the cross-level interaction of PTSD x AUD diagnosis predicting same-day and next-day alcohol consumption and desire to drink. As can be seen, the PTSD x AUD interaction was significant for same-day desire to drink as the dependent variable ( $p < .05$ ), showing that women with an AUD demonstrated a stronger positive association between number of PTSD symptoms and same-day desire to drink than women with no AUD. No other interaction effects were significant.

Finally, Table 4 shows results for multi-level models that examined the cross-level interaction of NA x AUD diagnosis predicting same-day and next-day alcohol involvement. The NA x AUD interaction predicting same-day alcohol consumption and same-day desire to drink were both significant. Specifically, the strength of the association between NA intensity and number of drinks consumed that same-day increased by 1.37 units for women with an AUD compared to women without an AUD. Further, the strength of association between NA and same-day desire to drink increased by 0.65 units for women with an AUD compared to women without an AUD. The NA x AUD interaction predicting next-day drinks was significant, but showed that the association between NA and next-day alcohol

<sup>7</sup>All multi-level models were re-analyzed using either mean drinks per drinking day or percent heavy drinking days, and baseline PCL-C severity scores as level-2 covariates, but inclusion of these variables did not appreciably alter findings.

<sup>8</sup>MacKinnon, Fairchild, and Fritz (2007) termed this “inconsistent mediation”, noting that a path from the predictor variable (number of PTSD symptoms) to the outcome variable (alcohol involvement) is implied if there is a path from the predictor variable to the mediator, and from the mediator to the outcome. This may occur when the entire effect of X on Y is due to the third variable.

consumption *decreased* by .39 units, or became significantly weaker, for women with an AUD than without.

**Post-hoc analysis**—To provide additional support for the negative reinforcement model of addiction- that that drinking arises as a way to alleviate the NA associated with PTSD symptoms- we tested alternative multi-level models that examined whether number of drinks consumed on the previous night would predict next-day PTSD symptoms and NA intensity. We also examined the impact of AUD diagnosis on these within-person associations. Models initially included day-of-the-week contrasts, but none were significant so these variables were set to zero. Results are presented in Table 5. The cross-level interaction of last-night's drinking x AUD diagnosis was significant for the model predicting next-day PTSD symptoms ( $b = 0.24, p < .05$ ) and suggested that the strength of association between last-night's drinking and next-day PTSD symptoms increased by 0.25 units for women with an AUD relative to women without. That is, women with an AUD experienced more intense PTSD symptoms on days following heavier drinking episodes than women without an AUD. Last-night's drinking did not significantly predict next-day NA, and AUD diagnosis did not have an impact on the association between last-night's drinking and next-day NA.

## Discussion

The goal of the present study was to examine daily covariations among alcohol consumption, desire to drink, NA, and PTSD symptoms in a sample of non-treatment-seeking female rape victims who completed 14 days of daily IVR monitoring. Specifically, we investigated (a) whether NA mediates the association between daily PTSD symptoms and same-day and next-day alcohol involvement (consumption and desire to drink) and (b) if lifetime AUD diagnosis impacts the strength of associations among daily PTSD, NA, and alcohol involvement.

Descriptive statistics revealed that the sample was comprised primarily of women with an AUD (61%). Not surprisingly, both retrospective (TLFB) and prospective (IVR) assessments revealed that women with an AUD consumed nearly twice as many drinks per drinking day than women without an AUD. Women overall reported moderate to severe levels of PTSD symptomatology, half met DSM-IV criteria for a diagnosis of PTSD, and experienced an average of 2 (out of 7 possible) PTSD symptoms per day. Correlations also showed that baseline PTSD symptom severity was positively and significantly correlated with aggregate levels of all daily factors (drinking, NA, PTSD, desire to drink). Daily desire to drink and daily alcohol consumption were positively correlated with all study variables, except for daily PTSD symptoms.

Results from multi-level models support a mediating effect of NA on the association between daily PTSD and same-day, but not next-day alcohol consumption and desire to drink. Specifically, NA was higher on days characterized by more intense PTSD symptoms and alcohol involvement (both number of drinks consumed and intensity to drink) was greater on days characterized by more severe NA. Even though PTSD symptoms were not directly related to alcohol use behavior in multi-level models, a test of the indirect effect was significant. From our review of the literature, conceptually this could be quite plausible:

Because PTSD and NA were measured so close together in time, it is possible that the variance in alcohol behavior associated with variability in PTSD symptoms was “cancelled out” or completely explained by variability in NA on that same-day. Our findings suggest that prior cross-sectional and longitudinal study results linking PTSD to alcohol involvement in women who have been sexually assaulted may be explained, at the daily level, via negative emotional distress that relates to their traumatic stress symptomatology. It is important to note that some emotions particularly relevant to individuals with PTSD, such as fear, guilt, or shame were not assessed in the current study, but should be explored in future research as potential mechanisms of the association between PTSD symptoms and alcohol involvement.

Important individual differences were also found between women with and without an AUD. First, the strength of association between NA and PTSD was *weaker* for women with an AUD relative to women without an AUD. Perhaps prolonged or heavy alcohol use in female rape victims may lead to emotional numbing and thus lower reactivity to NA (Bonnano et al., 2003; Mason et al., 2001). Second, as we hypothesized, women with an AUD consumed more drinks and had more intense desire to drink on days characterized by greater NA and more intense PTSD symptoms. Unexpectedly, women with an AUD showed a weaker association between NA and next-day alcohol consumption, relative to women with no AUD. However, this finding does not appear to completely contradict the negative reinforcement model: if women with a drinking problem experience a negative mood on one day, then they may be apt to drink alcohol on that same day to alleviate that distress. Our results suggest that the tendency to reduce emotional distress with alcohol may be effective in the short-term, in that it does not carry over to the next day, but in the long-term may be ineffective. Thus, alcohol may provide a momentary reprieve from NA that some rape victims experience in conjunction with symptoms of PTSD.

Finally an alternative mediation hypothesis did not show that NA mediated the association between drinks consumed on the previous night and next-day PTSD symptoms. This provides some preliminary evidence that female rape victims do consume alcohol as a way to manage distress related to PTSD symptoms. Results from these alternative models did show that last-night’s drinking predicted increases in next-day PTSD symptoms, but only for women with an AUD. Thus, even though drinking may have provided short-term reprieve from emotional distress associated with PTSD symptoms, taken in heavier quantities, it may have caused a rebound effect such that symptoms worsened once the alcohol wore off (Tomlinson, Tate, Anderson, McCarthy, & Brown, 2006).

Several important clinical implications could be gleaned from our results. First, providers who work with victims of sexual assault should focus on teaching women how to cope with daily emotional distress that may arise from post-traumatic stress by using pro-active behaviors, rather than engaging in maladaptive strategies like alcohol use. Second, women entering treatment for an AUD who have a history of sexual trauma may be at greater risk for relapse back to problem drinking compared to women without a trauma history if they are emotionally reactive (i.e., high levels of NA) and have moderate to severe PTSD symptomatology (Norman et al., 2007; Simpson et al., 2012). There is data to suggest that presence of a PTSD diagnosis can interfere with alcohol and substance use treatment

outcomes, and that treatment of the underlying substance use issue may help PTSD symptoms decrease over time (Hien et al., 2010; P. C. Ouimette, Brown, & Najavits, 1998; Read, Brown, & Kahler, 2004). Thus, sexual assault history and PTSD symptoms should be thoroughly screened in women who enter alcohol treatment programs and addressed concurrently with problem drinking. Third, chronic (daily) desire to drink, coupled with the distress of daily PTSD symptoms, may impede some women's self-efficacy to cope, further deteriorating a successful chance of abstinence from drinking upon entering alcohol treatment (P. Ouimette, Coolhart, Funderburk, Wade, & Brown, 2007). These are important clinical items to be addressed at the outset of treatment with this sub-group of women.

The proposed study has several strengths. It builds on recent research by using daily IVR to identify the links between subject distress (e.g., negative mood states and PTSD) and alcohol cravings/drinking among female rape victims. IVR methods allow for more detailed consideration of the proximal correlates of alcohol involvement, variability in behavior and experience within female rape victims, as well as testing of individual difference variables (AUD diagnosis) that moderate relationships among dynamically-changing factors (mood, substance use, mental health symptoms), relative to traditional paper-and-pencil assessment methods. Our results are consistent with prior research, and suggest PTSD symptoms can interfere with adaptive emotion-coping, and that intensity of negative affect may appear to have a stronger influence on daily alcohol consumption than the symptoms of PTSD (Norman et al., 2007; Ouimette et al., 2007). The findings have the potential to impact how interventions can be specifically tailored to sub-sets of women entering alcohol treatment with a rape history and with female rape victims with co-occurring alcohol use problems who may seek advice or help from rape counselors.

There were several limitations of this study. First, IVR data were collected one time a day, rather than at true "real time" random intervals throughout the day. In models that examined same-day associations, assessment of variables on the same day may artificially increase correlations between measures. Second, we examined lifetime rather than current AUD status, and thus did not determine whether the rape triggered development of alcohol problems or only exacerbated a pre-existing disorder. Similarly, women may have been heavy drinkers prior to the rape and data from the present study cannot address the question of whether drinking changed as a function of the sexual assault. Third, it is possible that IVR monitoring may have cued people to reduce their drinking (reactivity,) although current research suggests that reactivity is unlikely, or if it does exist, the influence on changing alcohol use behavior change is minimal (Ball et al., 2007; S. Shiffman, 2009). Fourth, we used a sample that had not been in treatment in the past 12-months so that we could model the naturally occurring associations among NA, PTSD symptoms, and alcohol use without the influence of intervention. However, this may have affected generalizability to more severely affected populations who may be more likely to seek treatment for their alcohol use problems or for a rape.

Taken together, study findings indicate that daily NA mediates the relationship between daily PTSD symptom severity and same-day, but not next-day alcohol involvement. In line with the extant research, we found that NA was higher on days in which women experienced more symptoms of PTSD and that NA was associated with greater alcohol consumption and

desire to drink on that same day. Additionally, AUD diagnosis was shown to differentially impact the relationships of NA and PTSD on drinking behavior. Findings have conceptual and policy-relevant implications for how to address problem drinking in female rape victims. Resources and training should also be provided to educate rape crisis treatment providers and first responders to screen for co-morbid PTSD and alcohol use in women presenting to rape crisis centers. Lastly, given the lack of concordance between some daily results and those previous cross-sectional or macro-longitudinal studies, conceptual models of rape-related mental health outcomes should be refined to incorporate acute and daily changing factors.

## Acknowledgments

Amy Cohn is now at the Schroeder Institute for Tobacco Research and Policy Studies.

This research was supported in part by NIDA grant P30DA028807 and USF grant MHBCSG – 0081305 from the College of Behavioral and Community Sciences. The content is solely the responsibility of the author(s) and does not necessarily represent the official views of the National Institute on Drug Abuse or the National Institutes of Health.

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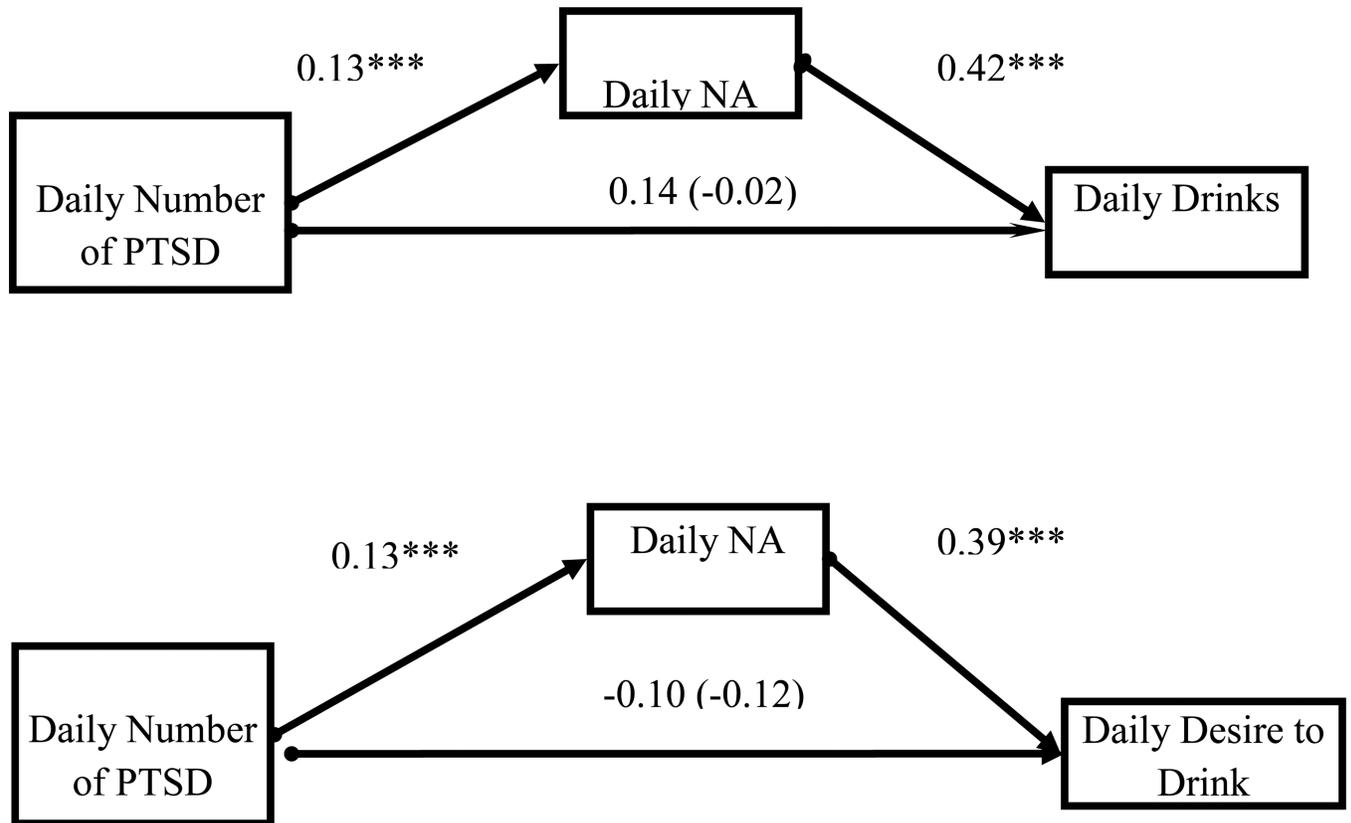
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**Figure 1.** Multi-level models showing mediation of NA in the relationship between daily PTSD symptoms and daily alcohol involvement. Unstandardized path coefficients are presented for each path. The path coefficient for the indirect effect is presented in parentheses.

**Table 1**

Descriptive statistics and correlations among baseline and daily (IVR) variables.

	Mean (SD)	1	2	3	4	5	6	7	8
1. PCL-C total	44.57 (15.30)	-	.03	.30*	-.01	.30*	.54***	.54***	.29*
2. Mean drinks Per drinking day	3.85 (3.18)		-	.61***	.50***	.60***	-.06	.20	.40***
3. Percent heavy drinking days	8% (12%)			-	.45***	.71***	.11	.21	.35**
4. AUD diagnosis	--				-	.47***	.16	.10	.54***
5. Daily drinks	1.38 (3.34)					-	.17	.29*	.63***
6. Daily PTSD symptoms	2.02 (2.24)						-	.54***	.23†
7. Daily NA	0.93 (0.93)								.48***
8. Daily desire To drink	0.78 (1.24)								-

Note. Daily factors are based on aggregate variables, not within-person associations (multi-level models). PCL-C = Posttraumatic stress disorder symptom checklist (civilian version); AUD = alcohol use disorder (1 = yes, 0 = no); NA = negative affect.

†  $p < .10$

\*  $p < .05$

\*\*  $p < .01$

\*\*\*  $p < .001$

**Table 2**

Multi-level model results of PTSD symptoms and AUD diagnosis predicting same-day Negative Affect (NA) intensity

NA Intensity (outcome variable)		
	<i>b</i>	<i>SE</i>
<b>Between-person Effects</b>		
AUD diagnosis	0.10	0.21
<b>Within-person effects</b>		
Daily PTSD symptoms	0.22***	0.03
<b>Within- x Between-person effects</b>		
PTSD symptoms x AUD	-0.13**	.05

*Note.* PTSD = post-traumatic stress disorder; AUD = Alcohol use disorder; *b* = unstandardized regression coefficient. Degrees of freedom (df) = 52 for level-2 variable and df = 706 for level-1 variable.

\*  
 $p < .05$

\*\*  
 $p < .01$

\*\*\*  
 $p < .001$

**Table 3**

Multi-level model results of daily PTSD symptoms and AUD diagnosis predicting same-day alcohol consumption and desire to drink.

	Same-Day Alcohol Consumption	Same-Day Desire to Drink	Next-Day Alcohol Consumption	Next-Day Desire to Drink
<b>Between-person Effects</b>	<i>b (SE)</i>	<i>b (SE)</i>	<i>b (SE)</i>	<i>b (SE)</i>
AUD diagnosis	2.27 (.40)***	1.06 (.22)***	2.05 (.38)***	0.64 (.18)***
<b>Within-person effects</b>				
Daily PTSD symptoms	0.02 (.12)	-0.06 (.10)	0.12 (.07)	0.05 (.03)
<b>Within- x Between-person effects</b>				
PTSD symptoms x AUD diagnosis	-0.05(.12)	0.14 (.06)*	0.07 (.07)	0.07 (.04)

*Note.* PTSD = post-traumatic stress disorder; AUD = Alcohol use disorder diagnosis; *b* = unstandardized regression coefficient; Degrees of freedom (df) = 52 for level-2 variable and df = 695 for level-1 variables. Six day-of-week orthogonal contrasts were included in models but not represented here. Level-1 variable is group-mean centered. Next-day models controlled for drinking or craving from the previous day.

\*  $p < .05$

\*\*  $p < .01$

\*\*\*  $p < .001$

**Table 4**

Multi-level model results of negative affect (NA) intensity and AUD diagnosis predicting same-day **and next-day** alcohol consumption and desire to drink

	Same Day Alcohol Consumption	Same-Day Desire to drink	Next-Day Alcohol Consumption	Next-Day Desire to Drink
<b>Between-person effects</b>	<i>b (SE)</i>	<i>b (SE)</i>	<i>b (SE)</i>	<i>b (SE)</i>
AUD diagnosis	2.95 (.46) ***	1.06 (.22)	1.87 (.37) ***	0.61 (.17) ***
<b>Within-person Effects</b>				
NA intensity	-1.27 (.43) **	-0.04 (.10)	0.38 (.14) **	-.02 (.12)
<b>Within- x Between person effects</b>				
NA x AUD Diagnosis	1.41 (.43) ***	0.71 (.12) ***	-0.39 (.15) **	-.09 (.16)

*Note.* AUD = Alcohol use disorder; *b* = unstandardized regression coefficient. Degrees of freedom (df) for same-day variables = 52 for level-2 variable and df = 695 for level-1 variables. Six day-of-week orthogonal contrasts were included in models but not represented here. Level-1 variable is group-mean centered. DF for next-day variables = 47 for level-variable and 699 for level-1 variables. Next-day models controlled for drinking or craving from the previous day.

\*  $p < .05$

\*\*  $p < .01$

\*\*\*  $p < .001$

**Table 5**

Multi-level model results for last-night's drinking (LND) and AUD diagnosis predicting next-day PTSD symptoms and negative affect (NA) intensity

Outcome	Predictors					
	LND		AUD Diagnosis		LND x AUD Diagnosis	
	B	SE	b	SE	b	SE
Next-day PTSD symptoms	-0.24*	0.12	0.91	0.56	0.24*	0.12
Next-day NA Intensity	-0.10	0.06	0.10	0.21	0.11 <sup>†</sup>	0.10

Note. AUD = alcohol use disorder; *b* = unstandardized regression coefficient. Degrees of freedom (df) = 52 for level-2 variable and df = 476 for level-1 variables in both models.

<sup>†</sup>  $p < .10$

\*  $p < .05$