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Examination of the Dynamic Interplay between Posttraumatic Stress Symptoms and Alcohol Misuse among Combat-Exposed Operation Enduring Freedom (OEF)/Operation Iraqi Freedom (OIF) Veterans

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Abstract

Background—Although alcohol misuse co-occurs with PTSD symptoms at a strikingly high rate (i.e., nearly 52% of men and 28% of women with PTSD also meet diagnostic criteria for an Alcohol Use Disorder; Kessler et al., 1995), the functional associations between these symptom types remain unclear.

Methods—The current study sought to clarify the nature of posttraumatic stress-alcohol misuse relations by employing a prospective longitudinal methodology - the latent difference score approach - to examine dynamic change in posttraumatic stress symptoms and alcohol misuse among 478 combat-exposed Veterans completing a longitudinal survey of post-deployment mental and physical health. This study builds on the existing literature, as most prior research has been limited to cross-sectional studies and has not explored prospective relations between specific PTSD symptom clusters and alcohol misuse.

Results—Consistent with the self-medication model, results indicated that PTSD symptoms demonstrate a prospective and proximal association with alcohol misuse during the assessment period; however, alcohol misuse did not appear to be a unique contributor to overall PTSD symptom exacerbation over time. Examination of individual PTSD symptom clusters revealed that

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more severe symptoms of intrusion and numbing, but not avoidance and hyperarousal, predicted greater alcohol misuse at subsequent time intervals.

Limitations—The constructs examined within this investigation relied on self-report data; diagnostic criteria for PTSD and/or Alcohol Use Disorders were not assessed. Future work may benefit from replicating these findings in clinical populations formally diagnosed with PTSD via clinician-administered structured interviews.

Conclusions—Findings underscore the importance of addressing PTSD symptoms in the context of alcohol treatment to facilitate improved drinking outcomes.

Keywords

Posttraumatic Stress Disorder; Combat; Trauma; Alcohol; Structural Equation Modeling

Emerging evidence suggests that posttraumatic stress symptoms and alcohol misuse are significant problems among military personnel (Fetzner et al., 2013; Goodwin et al., 2012; Sundin et al., 2011). This appears to be a notable issue for Veterans exposed to combat, particularly for those deployed to Afghanistan (Operation Enduring Freedom: OEF) and Iraq (Operations Iraqi Freedom: OIF). Recent studies indicate that approximately 12–39% of OEF/OIF Active Duty or National Guard and Reserve personnel evidence patterns of alcohol misuse (Bray and Hourani, 2007; Burnett-Zeigler et al., 2011; Eisen et al., 2012; Hoge et al., 2004; Jacobsen et al., 2008; Wilk et al., 2010). Increased problems with alcohol following deployment is hypothesized to be due, in part, to the emergence of symptoms of posttraumatic stress disorder (PTSD) that occur as a result of direct combat exposure (approximately 12–30% of Veterans seeking services at the Veterans' Healthcare Administration; Hoge et al., 2004; Seal et al., 2009; Thomas et al., 2010). Indeed, nearly half of the returning Veterans who screen positive for PTSD symptoms also endorse alcohol misuse (McDevitt-Murphy et al., 2010; Thomas et al., 2010).

Not surprisingly, individuals dually diagnosed with PTSD-alcohol misuse endorse greater overall impairment, presenting with more severe psychological and related symptoms (i.e., difficulties with memory and concentration), poorer functional health, higher incidence of other Axis I and II disorders, worse treatment outcomes, and higher mortality rates compared to individuals suffering from each disorder alone (Back et al., 2000; Blanco et al., 2013; Carter et al., 2011; Dragan, 2010; McDevitt-Murphy et al., 2010).

Despite growing recognition of the prevalence of PTSD and alcohol misuse, the functional associations between the severity of PTSD symptoms and drinking behavior remains unclear. Several theoretical models have been developed to explain the etiology and maintenance of this co-occurrence. Of the proposed models, the *self-medication model* has perhaps received the greatest scientific attention. According to this model (Baker et al., 2004; Khantzian, 2003), alcohol is consumed in an effort to alleviate distressing symptoms associated with PTSD. In short, individuals experiencing PTSD-related symptoms “treat” their symptoms with alcohol. Thus, the self-medication model posits that symptoms of PTSD precede and exert a causal effect on alcohol misuse (Stewart et al., 1998).

Conversely, according to the *susceptibility model*, chronic alcohol misuse prevents healthy adaptation to traumatic events, leading to exacerbations in physiological arousal and anxiety (Back et al., 2006). Therefore, in the aftermath of trauma exposure, heavy alcohol use may increase vulnerability to experiencing PTSD symptoms (Jacobsen et al., 2001).

The *mutual maintenance model* posits that a reciprocal relationship exists between alcohol misuse and PTSD symptoms (Kaysen et al., 2011; McFarlane et al., 2009). This model suggests that alcohol is used to suppress symptoms of PTSD, while repeated alcohol use impedes natural recovery from trauma, which in turn, exacerbates and maintains symptoms of PTSD. From this perspective, associations between PTSD symptoms and alcohol misuse are bidirectional in nature, influencing each other over time.

Although a large body of work has evaluated associations between PTSD symptom severity and alcohol misuse, there remain substantive gaps in the literature. First, the vast majority of research on this topic has employed cross-sectional study designs, which prohibit the ability to test temporal sequencing of symptoms over time (see Stewart, 1996, for a review). Further, studies that have utilized longitudinal methodologies have tended to limit analyses to the examination of the independent effects of PTSD symptoms on subsequent change in alcohol misuse (or the effects of alcohol misuse on subsequent change in PTSD symptoms), but have not examined the dynamic interplay or reciprocal changes in these symptom types over time. Second, the relatively few studies examining prospective PTSD-alcohol misuse associations have neglected to examine the impact of the individual PTSD symptom clusters on alcohol misuse (and vice versa), and instead have examined PTSD symptom severity more broadly. Together, these limitations are noteworthy as a failure to isolate how change in one variable leads proximally to change in the other variable (and vice versa) restricts our knowledge about ways to prevent and treat these co-occurring conditions. Indeed, in order to effectively manage this comorbidity (PTSD-alcohol misuse), it is imperative to understand the direction of influence in terms of symptom exacerbation and maintenance.

Of the studies that have investigated reciprocal relations between PTSD symptoms and alcohol misuse over time, the results have been somewhat equivocal. Some studies have demonstrated that PTSD symptoms drive subsequent increases in alcohol problems (Nickerson et al., 2014), while other investigations have suggested that PTSD symptoms and alcohol consumption reflexively influence each other over time (Read et al., 2013). Given these discrepant findings, the current study sought to clarify the nature of relations between symptoms of PTSD and alcohol misuse in a sample of combat-exposed Veterans; a population with exceedingly high rates of traumatic event exposure, PTSD, and substance use. A prospective longitudinal methodology was applied - the latent difference score approach (Hamagami and McArdle, 2001; King et al., 2006; King et al., 2009; McArdle, 2001; McArdle and Hamagami, 2001) - to examine dynamic change in the interplay between PTSD symptoms as well as specific symptom clusters and alcohol misuse among combat-exposed Veterans over time.

Building on past research and theory, and consistent with the self-medication model, we hypothesized that initial prior status on PTSD symptoms would be a positive predictor of subsequent change in alcohol misuse across the assessment period, whereas alcohol misuse

would not significantly predict subsequent change in PTSD symptoms. Further, given that prior work has documented differential relations between PTSD symptom clusters (intrusion, emotional numbing, avoidance, hyperarousal) and alcohol misuse (Jakupcak et al., 2010; Maguen et al., 2009; McFall et al., 1992; Nickerson et al., 2014; Scott et al., 2013), we hypothesized that unique effects would be observed between certain symptom clusters and alcohol misuse over time. Specifically, emerging evidence suggests that among OEF/OIF Veterans, emotional numbing may be a particularly salient group of symptoms involved with problematic alcohol misuse (Jakupcak et al., 2010; Scott et al., 2013). Therefore, we hypothesized that initial status of emotional numbing would be a positive predictor of subsequent change in alcohol misuse.

Material and Methods

Procedures

Data for the present study were drawn from a larger, longitudinal study of post-deployment mental and physical health functioning among recently deployed Veterans. A random sample of OEF/OIF Veterans, stratified by service component (50% Active Duty, 25% National Guard, and 25% other Reserve) and gender (50% women) was obtained from the Defense Manpower Data Center (DMDC). Selected Veterans were surveyed by mail at two time-points. The first assessment occurred within 12 months of returning from deployment (Time 1); respondents who completed the Time 1 survey were sent a second assessment battery approximately six months later (Time 2). On average, participants completed the two surveys 7.6 months apart ($range = 4.7\text{--}18.9$). Participants were compensated with a \$30 gift card for each completed survey. The investigation was carried out in accordance with the latest version of the Declaration of Helsinki; the study design was reviewed by an appropriate ethical committee; and, informed consent of the participants was obtained after the nature of the procedures had been fully explained. Additional details on the procedures for this study are described elsewhere (see Eisen et al., 2012).

Participants

Five hundred and ninety-six participants were assessed in the larger study; however, to ensure that all study participants had experienced a potentially traumatic event, we included only Veterans who reported at least some level of combat exposure ($range = 16\text{--}56$; $M = 24.09$; $SD = 8.09$) during their deployment ($n = 478$). Of these participants, approximately 55% identified as female ($n = 263$). At Time 1, the average age was 33.45 ($SD = 9.12$) years. Approximately 66% of the sample self-identified as Caucasian ($n = 317$), 14% as African-American/Black ($n = 68$), 12% as Hispanic ($n = 57$), 4% American Indian or Alaskan Native ($n = 19$), 3% Asian ($n = 13$), and 1% Native Hawaiian or other Pacific Islander ($n = 4$). The majority of the sample was either currently married or with a partner ($n = 263$; 55%) or never married ($n = 140$; 30%). Overall, the sample was deployed 1.76 ($SD = 1.57$) times; and, on average, deployments lasted for 262.5 ($SD = 145.09$) days. Approximately 60% of the sample endorsed alcohol misuse at Time 1, while 62% endorsed alcohol misuse at Time 2 per the 3-item Alcohol misuse Identification Test – Consumption questionnaire (AUDIT-C; Bush et al., 1998). Regarding PTSD symptoms, approximately 11% of the sample met

criteria for probable PTSD at both Time 1 and 2, based upon the military version of the PTSD Checklist (PCL-M; Weathers et al., 1993).

Measures

Combat experiences—Combat experiences, defined as exposure to typical warfare experiences such as firing a weapon, being fired on, and witnessing injury and death, were assessed using the Deployment Risk and Resilience Inventory (DRRI; King et al., 2003). This measure contains 15 items, which are quantified on a modified 5-point Likert response format (1 = *never*; 2 = *few times over entire deployment*; 3 = *few times each month*; 4 = *few times each week*; 5 = *daily or almost daily*), with higher scores reflecting greater combat exposure. As described above, participants who endorsed “never” on all of the items were excluded from the present analyses.

Posttraumatic stress symptoms—The widely used and well-validated PCL-M (Weathers et al., 1993) was used to assess posttraumatic stress symptoms. This measure contains 17 items corresponding to the DSM-IV symptom criteria for PTSD. Respondents rated each item on a 5-point response format (with anchors ranging from 1 = *Not at All* to 5 = *Extremely*). This scale has demonstrated high coefficient alphas and good test-retest reliability (Ruggiero et al., 2003), and is highly correlated with other measures of PTSD, including the Clinician-Administered PTSD Scale (Blake et al., 1990). The PCL has also demonstrated acceptable levels of discriminant validity relative to other forms of psychopathology (e.g., Ruggiero et al., 2003; Weathers et al., 1993). The current investigation utilized the PCL total score as well as the four factor model of intrusion, emotional numbing, avoidance, and hyperarousal, which has been empirically supported by confirmatory factor analyses (Hall et al., 2012; King et al., 1998; Mansfield et al., 2010).

Alcohol misuse—Quantity and frequency of alcohol misuse were assessed via the AUDIT-C. The AUDIT-C is a validated screening tool for alcohol misuse and has been used for routine screening in the primary care setting (Bradley et al., 2009; Bush et al., 1998). The AUDIT-C comprises the consumption questions of the original 10-item AUDIT (Babor et al., 1989) and performs similarly to the full AUDIT in terms of identifying the spectrum of alcohol misuse (Kriston et al., 2008; Reinert and Allen, 2007).

Analyses

Latent Difference Score Model—To examine the prospective, bidirectional relations between PTSD symptoms and alcohol misuse, we used a latent difference score structural equation model for dynamic change, also referred to as latent change score analysis (Hamagami and McArdle, 2001; King et al., 2006; King et al., 2009; McArdle, 2001; McArdle and Hamagami, 2001). Figure 1 depicts the path graphic representation of the bivariate latent difference score model in the context of the current study (McArdle and Boker, 1990; McArdle and Hamagami, 2001). Here, boxes represent observed variables, circles represent unobserved or latent variables, single-headed arrows represent regression weights, double-headed arrows represent variances or covariances, and the triangle is a placeholder for the estimation of means. A regression weight of 1 is assumed for unlabeled single-headed arrows, and labeled arrows are parameters potentially to be estimated. The

key component of the model is a latent or unobserved difference score (p : change in PTSD; p and P refer to PTSD; a : change in alcohol misuse; a and A refer to alcohol misuse). P and A are observed variables, which were assigned to three occasions (details of time class specification to follow). P is a composite of two latent variables, true score variable p and error e_P ; A is also a composite of two latent variables, true score variable a and error e_A . For PTSD, the model contains observed variables P_0 through P_2 , latent variables p_0 through p_2 , and errors e_{p0} through e_{p2} , which correspond to the three time classes of PTSD. The latent difference score of PTSD is represented by p_1 and p_2 . For alcohol misuse, the model contains observed variables A_0 through A_2 , latent variables a_0 through a_2 , and errors e_{A0} through e_{A2} , which correspond to the three time classes of alcohol misuse.

The alphas (α s) in the figure represent the autoregressive effects of prior status on latent difference scores, also referred to as proportional change coefficients, and may or may not be constrained to be equal over time. Nonstationarity, which reflects naturally occurring change (increase/decrease) in symptoms over time, is depicted by (S_p), and its effect is symbolized by the betas (β s), which are typically fixed at 1. The estimation of means and variances of initial status and constant change (μ_0 and Φ^2_0 , μ_S and Φ^2_S , respectively) as well as the covariance between the two (Φ_{0S}) are allowed within this model. Residual variances of measurement error (Ψ^2_s) are usually constrained to be equivalent.

With the bivariate latent difference score approach, change in a variable (PTSD or alcohol) at each time-point is a function of prior status on the other variable (alcohol or PTSD), controlling for autoregressive effects and nonstationarity. The primary goal is to determine the extent to which symptoms of PTSD influence change in the degree of alcohol misuse, and the extent to which alcohol misuse influences change in PTSD symptom severity. The gamma coefficients (γ_a and γ_p) represent the cross-variable lagged influences of PTSD symptom severity on change in alcohol misuse and alcohol misuse on change in PTSD symptom severity, respectively.

Data Analytic Strategy—As described earlier, PTSD symptom severity and alcohol misuse were assessed within the first 12 months following return from deployment and then again approximately six months later. Given that there was substantial dispersion in the actual timing of assessments around the targeted time-points, we implemented procedures outlined by King et al. (2006) wherein PTSD symptom severity and alcohol misuse scores were assigned to three time classes, created on the basis of the count of days since the return from deployment on which their specific assessment was completed (Time 1 = 123–323 days, Time 2 = 324–524 days, Time 3 = >525 days; King et al., 2006). Using this method, we systematically placed each participant's scores for PTSD symptom severity and alcohol misuse into either one or two (depending on the number of completed assessments) of the three time classes. Here, 406 Veterans completed the assessment at two time-points and 72 Veterans completed the assessment at one time-point. Of the Veterans completing two assessments, 39 had data that fell into the same time class, and therefore, only one data point was retained. Thus, 845 observations were included across the three time classes. In addition to missing data due to attrition, data were also missing by design based upon the time class assignments. Further analysis revealed that symptom severity (PTSD and alcohol misuse evaluated at Time 1 and Time 2) did not differ for those who provided complete versus

those who provided incomplete data, and therefore, data were assumed to be missing at random.

Using Mplus (Version 7.1; Muthen and Muthen, 2013) with the MAR assumption and full information maximum likelihood, we estimated the means and standard deviations for PTSD symptom severity (total score and symptoms cluster scores) and alcohol misuse across the time classes. We then estimated a series of bivariate latent difference score models (see Figure 1), for alcohol misuse and PTSD symptom severity, with separate models for total symptom severity and each of the four symptom clusters, in order to determine influences of PTSD symptom severity on change in alcohol misuse and alcohol misuse on change in PTSD symptom severity.

The latent variable of PTSD was comprised of a single indicator: PCL (either total sum score or cluster sum score, as appropriate). The latent variable of alcohol misuse was also comprised of a single indicator: total score from the AUDIT-C. For both PTSD and alcohol misuse, loadings and intercepts were fixed to 1, and measurement error residuals were constrained to be equal over time.

Proportional change coefficients (α s) were constrained to be equivalent in the PTSD total symptom severity and alcohol misuse model. However, for the following models we used unequal proportional change coefficients for alcohol misuse: PTSD intrusion and alcohol misuse; PTSD numbing and alcohol misuse; and PTSD avoidance and alcohol misuse. Similarly, for the PTSD hyperarousal and alcohol misuse model, we used unequal proportional change coefficients for both PTSD and alcohol misuse. Unequal proportional change coefficients were selected in the latter models as this yielded improved parameter estimates and model fit. Finally, cross-variable lagged coefficients were allowed to vary for all of the studied models.

Four indices were used to evaluate how well each model fit the data: Chi-square (χ^2), root mean square error of approximation (RMSEA), comparative fit index (CFI), and Tucker-Lewis index (TLI). A non-significant χ^2 , a RMSEA of .05 or less, a CFI above .95, and a TLI above .95 suggest a good-fitting model.

Results

Descriptive Statistics

Descriptive statistics for the three time classes that structured the data are presented in the upper portion of Table 1. The three time classes produced two time intervals. The latent difference scores were derived from these two time intervals: Time Class 1 to Time Class 2 and Time Class 2 to Time Class 3.

Maximum likelihood estimates of means and standard deviations for scores on the PCL (total score and symptom clusters) and AUDIT-C are presented in the lower portion of Table 1. On average, symptoms of PTSD and alcohol misuse increased over time. The dispersion of scores remained relatively stable across the three time classes as evidenced by the values of standard deviations.

Bivariate Latent Difference Score Models

Tables 2–6 present the results for the five bivariate latent difference score models evaluating the relations between alcohol misuse and total symptoms of PTSD, PTSD intrusion, PTSD numbing, PTSD avoidance, and PTSD hyperarousal, respectively. The upper portion of each table contains information on overall model-data fit. Results indicate that all of the models demonstrated good fit.

The lower portion of each table presents the parameter estimates for the models as well as the critical ratios. A critical ratio with an absolute value exceeding 1.96 is generally indicative of a significant estimate. The first set of double-columned rows presents the parameter estimates for the within-variable portions of the larger model, which are noted separately for alcohol misuse and the applicable PTSD index (total or symptom cluster score). As expected, the estimates of the initial status means for alcohol misuse and the PTSD index were significantly different from zero for all models (note: bolded *CR* values > 1.96). Similarly, the variance estimates of initial status were significant across all of the models for both the alcohol and PTSD variables. The constant change mean for alcohol misuse in the model with PTSD intrusion and PTSD avoidance as well as the constant change variance in the model with PTSD total score, PTSD intrusion, PTSD numbing, PTSD avoidance, and PTSD hyperarousal were significantly different from zero. The positive values for alcohol misuse's constant change component indicate that natural change (i.e., unmeasured factors) still contribute to the development of alcohol-related problems even in the presence of prior alcohol misuse and the relevant PTSD index. Across all models, prior status was significantly related to subsequent change in alcohol misuse as indicated by the strong and negative proportional change coefficients. For these models, higher scores on the AUDIT-C are expected to be followed by a decline in these scores at the next occasion.

A similar pattern of results emerge when examining the constant change components for PTSD. Specifically, the constant change mean for PTSD total score, PTSD numbing, and PTSD avoidance as well as the constant change variances for PTSD total score, PTSD numbing, and PTSD avoidance were significantly different from zero. The positive values for the PTSD constant change component indicate that natural change or other factors still contribute to the severity of PTSD symptoms even in the presence of prior symptoms of PTSD and alcohol misuse. The strong and negative proportional change coefficients for PTSD total score, PTSD numbing, and PTSD avoidance demonstrate that prior status is significantly related to subsequent change in PTSD symptoms: those with higher scores on these PTSD indices are expected to experience a decline in symptoms at subsequent assessments.

Parameter estimates for the associations between PTSD symptom severity and alcohol misuse appear in the lower portions of Tables 2–6. These relations are partially evident in the covariance between initial status for PTSD symptoms and initial status for alcohol misuse, in the covariance between initial status for PTSD symptoms and the constant change component for alcohol misuse, and in the covariance between the constant change component for PTSD symptoms and the initial status for alcohol misuse. Most critical to the

goals of the present study, the cross-variable lagged effects (i.e., the regressions of the latent difference scores for one variable on the prior latent true scores for the other variable) signify the covariation between PTSD symptom severity and alcohol misuse, controlling for other influences. Here, change in PTSD symptom severity was regressed on prior status of alcohol misuse, while controlling for autoregressive effects and nonstationarity in PTSD. Likewise, change in alcohol misuse was regressed on prior status of each PTSD symptoms cluster, while controlling for autoregressive effects and nonstationarity in alcohol misuse.

In terms of the prediction of change in PTSD symptom severity, results indicate that no significant association was observed between prior alcohol misuse and change in PTSD symptom severity. Specifically, the level of alcohol misuse reported at the earlier time-point did not appear to have a unique effect on the degree of change in PTSD symptoms experienced at the subsequent time-point.

Regarding the prediction of change in alcohol misuse, differential effects were observed amongst the PTSD indices. That is, PTSD total symptom severity, PTSD intrusion, and PTSD numbing were positive predictors of change in alcohol-related problems over the two time intervals. Individuals with more severe symptoms of PTSD at the earlier time-point are expected to have an increase in alcohol misuse over the subsequent time interval. However, for the models involving PTSD avoidance and hyperarousal, no significant association was observed between prior PTSD status and subsequent change in alcohol misuse.

Discussion

The present study provides a novel contribution to the literature by documenting dynamic relations between PTSD symptom severity and alcohol misuse in a large sample of combat-exposed OEF/OIF Veterans. Consistent with the self-medication model (Baker et al., 2004; Khantzian, 2003), results generally demonstrated a positive PTSD symptom severity-to-alcohol misuse link over time; however, the reverse direction of influence was not observed. These findings are in accord with past naturalistic studies suggesting that trauma-exposed populations manage or “treat” their symptoms of PTSD with repeated alcohol misuse; yet, problematic alcohol misuse does not appear to worsen the severity of PTSD symptoms over time (Nickerson et al., 2014).

Another important contribution of the current study was the focus on documenting specific PTSD symptom clusters that may underlie dynamic relations between PTSD and alcohol misuse. Findings indicated that the observed relation between PTSD symptom severity and changes in alcohol misuse in this sample of combat Veterans was primarily driven by intrusive thoughts and emotional numbing; neither avoidance nor hyperarousal evidenced unique relations to changes in alcohol misuse. It is possible that combat Veterans may use alcohol to mitigate intrusive thoughts of past traumatic events. Further, alcohol may serve to improve mood or facilitate social connections to counteract numbing. These findings are broadly consistent with past cross-sectional work, which has demonstrated that emotional numbing may be a particularly salient group of symptoms for understanding exacerbations and maintenance of problematic alcohol misuse (Jakupcak et al., 2010; Scott et al., 2013). This study extends past research by documenting the prospective effects of emotional

numbing on alcohol misuse, while also establishing that intrusive thoughts may be an important feature of PTSD to consider in the context of alcohol misuse.

The current study possesses a number of strengths, including a large sample of trauma-exposed Veterans, a prospective study design, and an analytic approach that allows for the examination of the dynamic change in PTSD-alcohol misuse associations over time. However, there are also several limitations and related future directions that warrant further consideration. First, this study focused exclusively on combat as the source of trauma exposure. While it is important to understand the associations between PTSD symptom severity and alcohol misuse within combat-exposed Veterans, it is unclear whether these findings would generalize to other populations experiencing different types of traumatic events. Therefore, future work may benefit from replicating these findings in other trauma-exposed populations to evaluate whether the pattern of findings is consistent.

Second, the constructs examined within this investigation relied on self-report data; diagnostic criteria for PTSD and/or Alcohol Use Disorders were not assessed. Further, the non-specificity of several of the PCL symptoms (e.g., irritability, sleep disturbance), suggests that this measure could be tapping general mood or anxiety symptoms, rather than PTSD symptoms specifically. While the objective of this study was to examine how PTSD symptoms impact alcohol misuse (and vice versa), and was not to assess diagnostic criteria per se, it nonetheless would be useful to replicate these findings in clinical populations formally diagnosed with PTSD via clinician-administered structured interviews. Additionally, given that the diagnostic criteria for PTSD and Alcohol Use Disorders have recently changed with the revision of the DSM-5, future work would benefit from examination of these findings using measurement tools reflecting the updated criteria (i.e., PCL-5).

Third, the current study examined PTSD symptoms and alcohol misuse in Veterans following return from their most recent deployment. It is possible, however, that symptoms of PTSD and problematic drinking preceded the index deployment. Indeed, examination of sample characteristics indicated that, on average, Veterans completed more than one deployment ($M = 1.76$; $SD = 1.57$). Likewise, this study did not take into account past trauma exposure that may have occurred prior to military service. Thus, the assessed symptomatology (e.g., PTSD and alcohol misuse) could be residual from previous deployments and/or lifetime trauma history, and may not be exclusively related to the most recent combat exposure.

Despite these limitations, the present findings offer insight into dynamic changes between PTSD symptoms and alcohol misuse in combat-exposed OEF/OIF Veterans. From a clinical perspective, these results highlight the importance of addressing PTSD symptoms in the context of alcohol treatment. Specifically, it may be advisable to a) educate patients on the role that PTSD symptoms (particularly emotional numbing and intrusive thoughts) may play in the exacerbation of drinking behavior; and b) target and decrease symptoms of PTSD in order to facilitate improved drinking outcomes. Together, this work highlights the need for integrated mental health treatments designed to concurrently intervene with PTSD and alcohol misuse.

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Highlights

- PTSD symptom severity demonstrates a prospective and proximal association with alcohol misuse during the assessment period; however, alcohol misuse does not appear to be a unique contributor to overall PTSD symptom exacerbation over time.
- Examination of individual PTSD symptom clusters revealed that more severe symptoms of intrusion and numbing, but not avoidance and hyperarousal, predicted greater alcohol misuse at subsequent time intervals.
- Findings underscore the importance of addressing PTSD symptoms in the context of alcohol treatment to facilitate improved drinking outcomes.

Figure 1.

Bivariate dual change latent difference score model. To simplify presentation, single-indicator measurement components are depicted.

Table 1

Descriptive statistics for time structure, PTSD symptoms, and alcohol misuse.

	Time Class 1 (123–323 Days)	Time Class 2 (324–524 Days)	Time Class 3 (>524 Days)
Number of Observations	216	375	254
Mean Days to Assessment	229.95	419.40	644.15
Median Days to Assessment	231	413	626.5
Standard Deviation	56.14	54.58	89.55
<hr/>			
PTSD Total			
<i>M (SD)</i>	30.63 (13.20)	31.48 (13.86)	32.07 (14.19)
<i>Range</i>	17–78	17–85	17–83
PTSD Intrusion			
<i>M (SD)</i>	8.14 (4.17)	8.63 (4.33)	8.60 (4.39)
<i>Range</i>	5–25	5–25	5–25
PTSD Numbing			
<i>M (SD)</i>	8.68 (4.00)	8.75 (4.27)	8.96 (4.37)
<i>Range</i>	5–21	5–25	5–23
PTSD Avoidance			
<i>M (SD)</i>	3.21 (1.83)	3.47 (2.02)	3.52 (2.09)
<i>Range</i>	2–10	2–10	2–10
PTSD Hyperarousal			
<i>M (SD)</i>	10.60 (4.81)	10.63 (4.64)	10.99 (4.75)
<i>Range</i>	5–25	5–25	5–25
AUDIT-C			
<i>M (SD)</i>	3.51 (2.20)	3.90 (2.56)	4.02 (2.37)
<i>Range</i>	0–12	0–12	0–12

Note. PTSD = posttraumatic stress disorder assessed via the Posttraumatic Stress Disorder Checklist – Military Version (PCL-M); AUDIT-C = 3-item version of the Alcohol misuse Disorders Identification Test.

Table 2

Bivariate latent difference score model for total PTSD symptoms and alcohol misuse.

Fit Indices		
χ^2/df	3.07/5	
CFI	1.0	
TLI	1.0	
RMSEA	.00 (90% CI = .00–.05)	
Parameter Estimates	PTSD Total	Alcohol Misuse
Initial Status Means (μ_{p0} ; μ_{a0})	30.42 (39.76)	2.19 (15.20)
Initial Status Variances (Φ^2_{p0} ; Φ^2_{a0})	147.67 (9.05)	3.93 (6.06)
Constant Change Means (μ_{Sp} ; μ_{Sa})	30.87 (4.05)	.72 (.71)
Constant Change Variances (Φ^2_{Sp} ; Φ^2_{Sa})	167.20 (2.21)	16.43 (4.65)
Initial Status with Constant Change (Φ^2_{p0Sp} ; Φ^2_{a0Sa})	139.47 (3.42)	6.77 (8.81)
Proportional Change		
PTSD Total (α_p)	−.98 (−3.87) [−1.40, −.56]	
Alcohol Misuse (α_a)	−2.02 (−9.40) [−2.38, −1.67]	
PTSD Total – Alcohol Misuse Associations		
Initial Status p with Initial Status a (Φ_{p0a0})	6.57 (3.36) [3.35, 9.78]	
Initial Status p with Constant Change a (Φ_{p0Sa})	−4.87 (−.93) [−13.50, 3.77]	
Constant Change p with Initial Status a (Φ_{Spa0})	6.28 (2.03) [1.18, 11.38]	
$a_0 \rightarrow p_1$ (γ_{p1})	−.28 (−.43) [−1.36, .80]	
$a_1 \rightarrow p_2$ (γ_{p2})	−.39 (−.69) [−1.30, .53]	
$p_0 \rightarrow a_1$ (γ_{a1})	.13 (3.51) [.07, .19]	
$p_1 \rightarrow a_2$ (γ_{a2})	.11 (3.13) [.05, .17]	
Measurement Model		
Error AUDIT-C	1.60 (3.75)	
Error PCL Total	30.26 (9.48)	

Note. Entries in the table's lower portion are unstandardized parameter estimates associated with critical ratios (*CRs*) in parentheses. Salient *CRs* greater than 1.96 appear in bold. 90% confidence intervals appear in brackets. Symbols correspond with those highlighted in the text and used in Figure 1, where p represents PTSD total symptom severity and a represents alcohol misuse. PTSD = posttraumatic stress disorder; PCL =

Posttraumatic Stress Disorder Checklist – Military Version; AUDIT-C = 3-item version of the Alcohol misuse Disorders Identification Test; χ^2 = chi square; df = degrees of freedom; CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root mean square error of approximation; CI = confidence interval; $a_0 \rightarrow p_1$ = latent alcohol misuse predicting subsequent PTSD latent difference score (Time Class 1 to Time Class 2); $a_1 \rightarrow p_2$ = latent alcohol misuse predicting subsequent PTSD latent difference score (Time Class 2 to Time Class 3); $p_0 \rightarrow a_1$ = latent PTSD predicting subsequent alcohol misuse latent difference score (Time Class 1 to Time Class 2); $p_1 \rightarrow a_2$ = latent PTSD predicting subsequent alcohol misuse latent difference score (Time Class 2 to Time Class 3).

Table 3

Bivariate latent difference score model for PTSD intrusion and alcohol misuse.

<i>Fit Indices</i>		
χ^2/df	2.79/5	
CFI	1.0	
TLI	1.0	
RMSEA	.00 (90% CI = .00–.05)	
<hr/>		
<i>Parameter Estimates</i>	PTSD Intrusion	Alcohol Misuse
Initial Status Means (μ_{p0} ; μ_{a0})	7.39 (30.84)	2.15 (14.81)
Initial Status Variances (Φ^2_{p0} ; Φ^2_{a0})	14.78 (5.88)	3.92 (5.80)
Constant Change Means (μ_{Sp} ; μ_{Sa})	10.12 (1.88)	1.94 (1.99)
Constant Change Variances (Φ^2_{Sp} ; Φ^2_{Sa})	26.91 (.94)	15.50 (4.05)
Initial Status with Constant Change (Φ^2_{p0Sp} ; Φ^2_{a0Sa})	18.93 (1.61)	6.84 (5.31)
<i>Proportional Change</i>		
PTSD Intrusion (α_p)	−1.28 (−1.85) [−2.43, −.14]	
Alcohol Misuse (α_a)	−1.90 (− 8.41) [−2.27, −1.53]	
Alcohol Misuse (α_{a2})	−1.76 (− 8.47) [−2.10, −1.42]	
<i>PTSD Intrusion – Alcohol Misuse Associations</i>		
Initial Status p with Initial Status a (Φ_{p0a0})	1.43 (2.18) [.35, 2.51]	
Initial Status p with Constant Change a (Φ_{p0Sa})	−1.66 (−.89) [−4.72, 1.41]	
Constant Change p with Initial Status a (Φ_{Spa0})	2.54 (1.18) [−1.02, 6.09]	
$a_0 \rightarrow p_1$ (γ_{p1})	−.18 (−.51) [−.76, .40]	
$a_1 \rightarrow p_2$ (γ_{p2})	−.13 (−.46) [−.59, .33]	
$p_0 \rightarrow a_1$ (γ_{a1})	.33 (2.43) [.11, 1.56]	
$p_1 \rightarrow a_2$ (γ_{a2})	.28 (2.11) [.06, .50]	
<i>Measurement Model</i>		
Error AUDIT-C	1.80 (3.89)	
Error PCL Intrusion	3.10 (4.33)	

Note. Entries in the table's lower portion are unstandardized parameter estimates associated with critical ratios (CRs) in parentheses. Salient CRs greater than 1.96 appear in bold. 90% confidence intervals appear in brackets. Symbols correspond with those highlighted in the text and used in Figure 1, where p represents PTSD intrusion and a represents alcohol misuse. PTSD = posttraumatic stress disorder; PCL = Posttraumatic Stress Disorder Checklist – Military Version; AUDIT-C = 3-item version of the Alcohol misuse Disorders Identification Test; χ^2 = chi square; df = degrees of freedom; CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root mean square error of approximation; CI = confidence interval; $a_0 \rightarrow p_1$ = latent alcohol misuse predicting subsequent PTSD intrusion latent difference score (Time Class 1 to Time Class 2); $a_1 \rightarrow p_2$ = latent alcohol misuse predicting subsequent PTSD intrusion latent difference score (Time Class 2 to Time Class 3); $p_0 \rightarrow a_1$ = latent PTSD intrusion predicting subsequent alcohol misuse latent difference score (Time Class 1 to Time Class 2); $p_1 \rightarrow a_2$ = latent PTSD intrusion predicting subsequent alcohol misuse latent difference score (Time Class 2 to Time Class 3).

Table 4

Bivariate latent difference score model for PTSD numbing and alcohol misuse.

<i>Fit Indices</i>		
χ^2/df	8.69/5	
CFI	.99	
TLI	.98	
RMSEA	.04 (90% CI = .00–.08)	
<hr/>		
<i>Parameter Estimates</i>	PTSD Numbing	Alcohol Misuse
Initial Status Means (μ_{p0} ; μ_{a0})	7.82 (31.08)	2.19 (15.29)
Initial Status Variances (Φ^2_{p0} ; Φ^2_{a0})	12.54 (6.56)	4.01 (6.14)
Constant Change Means (μ_{Sp} ; μ_{Sa})	9.02 (3.72)	1.46 (1.42)
Constant Change Variances (Φ^2_{Sp} ; Φ^2_{Sa})	17.97 (1.99)	17.54 (4.71)
Initial Status with Constant Change (Φ^2_{p0Sp} ; Φ^2_{a0Sa})	12.83 (2.70)	7.07 (5.94)
<i>Proportional Change</i>		
PTSD Numbing (α_p)	−1.14 (− 3.50) [−1.67, −.60]	
Alcohol Misuse (α_{a1})	−2.09 (− 9.17) [−2.47, −1.72]	
Alcohol Misuse (α_{a2})	−1.87 (− 8.83) [−2.22, −1.52]	
<i>PTSD Numbing – Alcohol Misuse Associations</i>		
Initial Status p with Initial Status a (Φ_{p0a0})	2.05 (3.28) [1.02, 3.08]	
Initial Status p with Constant Change a (Φ_{p0Sa})	−1.15 (−.68) [−3.90, 1.61]	
Constant Change p with Initial Status a (Φ_{Spa0})	1.68 (1.51) [−.15, 3.50]	
$a_0 \rightarrow p_1$ (γ_{p1})	−.02 (−.10) [−.41, .36]	
$a_1 \rightarrow p_2$ (γ_{p2})	−.04 (−.20) [−.38, .29]	
$p_0 \rightarrow a_1$ (γ_{a1})	.44 (2.97) [.19, .68]	
$p_1 \rightarrow a_2$ (γ_{a2})	.37 (2.69) [.14, .59]	
<i>Measurement Model</i>		
Error AUDIT-C	1.49 (3.17)	
Error PCL Numbing	4.31 (8.85)	

Note. Entries in the table's lower portion are unstandardized parameter estimates associated with critical ratios (CRs) in parentheses. Salient CRs greater than 1.96 appear in bold. 90% confidence intervals appear in brackets. Symbols correspond with those highlighted in the text and used in Figure 1, where p represents PTSD numbing and a represents alcohol misuse. PTSD = posttraumatic stress disorder; PCL = Posttraumatic Stress Disorder Checklist – Military Version; AUDIT-C = 3-item version of the Alcohol misuse Disorders Identification Test; χ^2 = chi square; df = degrees of freedom; CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root mean square error of approximation; CI = confidence interval; $a_0 \rightarrow p_1$ = latent alcohol misuse predicting subsequent PTSD numbing latent difference score (Time Class 1 to Time Class 2); $a_1 \rightarrow p_2$ = latent alcohol misuse predicting subsequent PTSD numbing latent difference score (Time Class 2 to Time Class 3); $p_0 \rightarrow a_1$ = latent PTSD numbing predicting subsequent alcohol misuse latent difference score (Time Class 1 to Time Class 2); $p_1 \rightarrow a_2$ = latent PTSD numbing predicting subsequent alcohol misuse latent difference score (Time Class 2 to Time Class 3).

Table 5

Bivariate latent difference score model for PTSD avoidance and alcohol misuse.

<i>Fit Indices</i>		
χ^2/df		.54/5
CFI		1.0
TLI		1.0
RMSEA		.00 (90% CI = .00–.00)
<hr/>		
<i>Parameter Estimates</i>	PTSD Avoidance	Alcohol Misuse
Initial Status Means (μ_{p0} ; μ_{a0})	2.27 (20.19)	2.16 (15.01)
Initial Status Variances (Φ^2_{p0} ; Φ^2_{a0})	2.29 (6.91)	3.87 (5.86)
Constant Change Means (μ_{sp} ; μ_{sa})	2.01 (3.69)	2.88 (3.16)
Constant Change Variances (Φ^2_{sp} ; Φ^2_{sa})	2.21 (2.72)	13.58 (3.96)
Initial Status with Constant Change (Φ^2_{p0sp} ; Φ^2_{a0sa})	1.70 (3.43)	6.50 (5.10)
<i>Proportional Change</i>		
PTSD Avoidance (α_p)	−.79 (−4.18) [−1.10, −.48]	
Alcohol Misuse (α_a)		−1.78 (−8.11) [−2.14, −1.42]
Alcohol Misuse (α_{a2})		−1.62 (−8.27) [−1.95, −1.30]
<i>PTSD Avoidance – Alcohol Misuse Associations</i>		
Initial Status p with Initial Status a (Φ_{p0a0})	.40 (1.41) [−.07, .88]	
Initial Status p with Constant Change a (Φ_{p0sa})	1.70 (3.43) [.88, 2.51]	
Constant Change p with Initial Status a (Φ_{spa0})	.44 (1.23) [−.15, 1.04]	
$a_0 \rightarrow p_1$ (γ_{p1})	.01 (.05) [−.17, .18]	
$a_1 \rightarrow p_2$ (γ_{p2})	.00 (.02) [−.14, .14]	
$p_0 \rightarrow a_1$ (γ_{a1})	.56 (1.79) [.05, 1.07]	
$p_1 \rightarrow a_2$ (γ_{a2})	.35 (1.31) [−.09, .79]	
<i>Measurement Model</i>		
Error AUDIT-C	1.79 (3.95)	
Error PCL Avoidance	1.07 (9.14)	

Note. Entries in the table's lower portion are unstandardized parameter estimates associated with critical ratios (CRs) in parentheses. Salient CRs greater than 1.96 appear in bold. 90% confidence intervals appear in brackets. Symbols correspond with those highlighted in the text and used in Figure 1, where p represents PTSD avoidance and a represents alcohol misuse. PTSD = posttraumatic stress disorder; PCL = Posttraumatic Stress Disorder Checklist – Military Version; AUDIT-C = 3-item version of the Alcohol misuse Disorders Identification Test; χ^2 = chi square; df = degrees of freedom; CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root mean square error of approximation; CI = confidence interval; $a_0 \rightarrow p_1$ = latent alcohol misuse predicting subsequent PTSD avoidance latent difference score (Time Class 1 to Time Class 2); $a_1 \rightarrow p_2$ = latent alcohol misuse predicting subsequent PTSD avoidance latent difference score (Time Class 2 to Time Class 3); $p_0 \rightarrow a_1$ = latent PTSD avoidance predicting subsequent alcohol misuse latent difference score (Time Class 1 to Time Class 2); $p_1 \rightarrow a_2$ = latent PTSD avoidance predicting subsequent alcohol misuse latent difference score (Time Class 2 to Time Class 3).

Table 6

Bivariate latent difference score model for PTSD hyperarousal and alcohol misuse.

Fit Indices		
χ^2/df	.16/4	
CFI	1.0	
TLI	1.0	
RMSEA	.00 (90% CI = .00–.00)	
Parameter Estimates		
Initial Status Means (μ_{p0} ; μ_{a0})	9.94 (35.57)	2.18 (15.10)
Initial Status Variances (Φ^2_{p0} ; Φ^2_{a0})	18.15 (8.78)	4.00 (6.17)
Constant Change Means (μ_{Sp} ; μ_{Sa})	7.65 (1.10)	−.77 (−.21)
Constant Change Variances (Φ^2_{Sp} ; Φ^2_{Sa})	10.63 (.59)	18.26 (2.35)
Initial Status with Constant Change (Φ^2_{p0Sp} ; Φ^2_{a0Sa})	12.47 (.99)	6.50 (4.88)
Proportional Change		
PTSD Hyperarousal (α_{p1})	−.76 (−1.02) [−1.99, .47]	
PTSD Hyperarousal (α_{p2})	−.69 (−.87) [−1.99, .61]	
Alcohol Misuse (α_{a1})		−2.15 (− 5.59) [−2.79, −1.52]
Alcohol Misuse (α_{a2})		−1.98 (− 5.18) [−2.61, −1.35]
PTSD Hyperarousal – Alcohol Misuse Associations		
Initial Status p with Initial Status a (Φ_{p0a0})	3.18 (4.20) [1.93, 4.42]	
Initial Status p with Constant Change a (Φ_{p0Sa})	−3.68 (−.55) [−14.77, 7.41]	
Constant Change p with Initial Status a (Φ_{Spa0})	2.63 (1.38) [−.50, 5.77]	
$a_0 \rightarrow p_1$ (γ_{p1})	−.14 (−.34) [−.78, .51]	
$a_1 \rightarrow p_2$ (γ_{p2})	−.39 (−.97) [−1.04, .27]	
$p^0 \rightarrow a_1$ (γ_{a1})	.58 (1.38) [−.11, 1.27]	
$p_1 \rightarrow a_2$ (γ_{a2})	.55 (1.25) [−.18, 1.28]	
Measurement Model		
Error AUDIT-C	1.64 (3.76)	
Error PCL Hyperarousal	5.20 (10.19)	

Note. Entries in the table's lower portion are unstandardized parameter estimates associated with critical ratios (*CRs*) in parentheses. Salient *CRs* greater than 1.96 appear in bold. 90% confidence intervals appear in brackets. Symbols correspond with those highlighted in the text and used in Figure 1, where p represents PTSD hyperarousal and a represents alcohol misuse. PTSD = posttraumatic stress disorder; PCL = Posttraumatic Stress Disorder Checklist – Military Version; AUDIT-C = 3-item version of the Alcohol misuse Disorders Identification Test; χ^2 = chi square; df = degrees of freedom; CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root mean square error of approximation; CI = confidence interval; $a_0 \rightarrow p_1$ = latent alcohol misuse predicting subsequent PTSD hyperarousal latent difference score (Time Class 1 to Time Class 2); $a_1 \rightarrow p_2$ = latent alcohol misuse predicting subsequent PTSD hyperarousal latent difference score (Time Class 2 to Time Class 3); $p_1 \rightarrow a_1$ = latent PTSD hyperarousal predicting subsequent alcohol misuse latent difference score (Time Class 1 to Time Class 2); $p_1 \rightarrow a_2$ = latent PTSD hyperarousal predicting subsequent alcohol misuse latent difference score (Time Class 2 to Time Class 3).