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Heterogeneity in the Co-occurrence of Substance Use and Posttraumatic Stress Disorder: A Latent Class Analysis Approach

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Abstract

Objectives.—Posttraumatic stress disorder (PTSD) often co-occurs with substance use (SU). Although there has been independent research on subgroups of participants based on their PTSD or SU responses, rarely are PTSD-SU typologies examined consistent with a precision medicine approach (and corresponding person-centered statistical approaches). The current study examined the nature and construct validity (covariates of depression, physical aggression, verbal aggression, anger, hostility, reckless and self-destructive behaviors [RSDB]) of the best-fitting latent class solution in categorizing participants based on PTSD (PTSD Checklist for DSM-5) and alcohol/drug use responses (Alcohol Use and Disorders Identification Test Alcohol Consumption Questions, Drug Abuse Screening Test).

Methods.—The sample included 375 trauma-exposed participants recruited from Amazon's Mechanical Turk online labor market.

Results.—Latent class analyses indicated an optimal three-class solution (Low PTSD/SU, Moderate PTSD/Drug and High Alcohol, High PTSD/SU). Multinomial logistic regressions indicated that depression ($OR = 1.22$) and frequency of RSDBs ($OR = 1.20$) were significant predictors of the Moderate PTSD/Drug and High Alcohol Class versus the Low PTSD/SU Class. Depression ($OR = 1.55$) and frequency of RSDBs ($OR = 1.19$) were significant predictors of the High PTSD/SU Class versus the Low PTSD/SU Class. Only depression ($OR = 1.27$) was a

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significant predictor of the High PTSD/SU Class versus the Moderate PTSD/Drug and High Alcohol Class.

Conclusions.—Results provide construct validity support for three meaningful latent classes with unique relations with depression and RSDBs. These findings improve our understanding of heterogeneous PTSD-SU comorbidity patterns and highlight acknowledgment of such subtyping (subgrouping) in considering differential treatment options, treatment effectiveness, and resource allocation.

Keywords

PTSD; alcohol use; drug use; latent class analyses; depression; reckless behaviors; aggression

1. Introduction

Posttraumatic stress disorder (PTSD) frequently co-occurs with substance use (SU; Read, Brown, & Kahler, 2004). Individuals with co-occurring PTSD and SU report greater symptom severity, greater functional impairment, and a poorer treatment response (McCauley, Killeen, Gros, Brady, & Back, 2012). Thus, subsets of individuals with co-occurring PTSD and SU may require unique and personalized treatment strategies. However, challenges in capturing PTSD-SU co-occurrence patterns/typologies have hindered the development of personalized treatments.

First, existing theoretical models of PTSD-SU co-occurrence are relatively narrow in scope. For instance, the *self-medication* and *negative reinforcement* models indicate that some individuals may use specific substances to manage PTSD-distress (Khantzian, 1997; Khantzian, 1999; Stewart, Pihl, Conrod, & Dongier, 1998) and avoid/escape negative affect (Baker, Piper, McCarthy, Majeskie, & Fiore, 2004); in line with these models, treatments target negative affect symptoms of PTSD anticipating concurrent SU reduction. However, emotion regulation may not be the only mechanism underlying SU in subsets of individuals with PTSD (Hall & Queer, 2007; Lembke, 2012); hence, we need to consider the distinct affective and non-affective PTSD symptoms in relation to a range of substances to better understand and treat the PTSD-polysubstance use co-occurrence (Anderson, Hruska, Boros, Richardson, & Delahanty, 2017; Lembke, 2012). Second, heterogeneity within the PTSD and SU diagnostic categories may contribute to subgroups endorsing different combinations of PTSD and/or SU symptoms (Galatzer-Levy, Nickerson, Litz, & Marmar, 2013; Mills, Teesson, Ross, & Peters, 2006). Treatment response likely varies across different subgroups. Although dual-diagnosis treatment approaches (Hien et al., 2009) are often recommended for PTSD-SU, such treatments (e.g., Seeking Safety) do not yield the same extent of symptom reduction for all clients (Najavits & Hien, 2013). A clearer typology of how subpopulations of patients differ based on their constellation of PTSD-SU symptoms is an essential prerequisite for personalized treatments.

A *precision medicine* approach holds promise in this regard. Rather than relying on diagnoses alone, this framework classifies individuals into subgroups/strata based on various relevant indicators (e.g., psychosocial, biological; Hambur & Collins, 2010; König, Fuchs, Hansen, von Mutius, & Kopp, 2017; McGrath & Ghera, 2016), thereby offering a

foundation towards personalized treatments for meaningful subgroups of individuals (Insel, 2014; Jameson & Longo, 2015; König et al., 2017). Consistent with this framework, person-centered approaches (e.g., latent class analysis; LCA) are useful for identifying these distinct subgroups based on reported symptoms (Vaidyanathan, Patrick, & Iacono, 2011), which are compared on meaningful physical and psychological health correlates to ascertain their construct validity (Kline, 2011; McCutcheon, 1987). Notably, few studies have harnessed person-centered approaches supporting a precision medicine framework to address PTSD-SU typologies (see Table 1). Addressing this gap in the literature, we examined the number and nature of meaningful subgroups of participants based on distinct constellations of PTSD and SU (alcohol and drug use) facets.

Based on prior research (Connor, Gullo, White, & Kelly, 2014; Contractor, Armour, Shea, Mota, & Pietrzak, 2016; Contractor, Caldas, Weiss, & Armour, 2018), we hypothesized three/four subgroups. To establish their construct validity, we examined these subgroups' distinct associations with clinically meaningful health outcomes relevant to PTSD and SU, namely depression (Bonde et al., 2016; Currie et al., 2005; Swendsen & Merikangas, 2000), reckless and self-destructive behaviors (RSDBs; Contractor, Weiss, Dranger, Ruggero, & Armour, 2017; Walther, Morgenstern, & Hanewinkel, 2012; Weiss, Tull, Sullivan, Dixon-Gordon, & Gratz, 2015), and aggression (Chermack et al., 2008; Contractor, Armour, Wang, Forbes, & Elhai, 2015; Olatunji, Ciesielski, & Tolin, 2010). We hypothesized that RSDBs, depression, and aggression would predict membership in a greater PTSD-SU severity subgroup. Identification of such subgroups delineates symptom co-occurrence patterns and highlights subgroups at elevated clinical severity (high-risk; Babor & Caetano, 2006) such as those reporting more RSDBs and other problematic behaviors. These subgroups may differ in their underlying mechanisms and treatment response; this work paves the way for referral- and treatment-matching services to optimize resources and treatment outcomes (Babor & Caetano, 2006; K. Brady, T., Killeen, Brewerton, & Lucerini, 2000).

2. Methods

2.1. Procedure/Participants

The study was conducted in accordance with the Declaration of Helsinki and the University of North Texas Institutional Review Board approved the study. The current study utilized a cross-sectional approach administering self-report surveys to a convenience (non-probability) sample. We posted the study description (45–60 minute survey to develop a post-trauma reckless behaviors measure), compensation, and eligibility information as a Human Intelligence Task (HIT) on Amazon's Mechanical Turk (MTurk) crowdsourcing platform. Potential participants ("workers") accessed the HIT; those who accepted it were provided a Qualtrics survey link displaying questions to assess eligibility, valid responding, and variables of interest.

Inclusionary criteria included 18 years, living in North America, fluency in the ability to read, write, and speak English, and endorsing a traumatic event assessed by the first Primary Care PTSD Screen for *DSM-5* (PC-PTSD-5; Prins et al., 2015) item (e.g., serious accident/fire, physical/sexual assault, earthquake/flood, war, seeing someone be killed/seriously injured, having a loved one die through homicide/suicide). The PC-PTSD (DSM-IV)

demonstrates good test-retest reliability ($r = .83$) and predictive validity ($r = .83$; Prins et al., 2003). The PC-PTSD-5 demonstrates good content validity, face validity, and diagnostic accuracy (Prins et al., 2016) and is a useful screen for PTSD symptoms in online survey studies (Cavanaugh, Campbell, & Messing, 2014; Grant, Pedersen, & Neighbors, 2016; Kolehmainen et al., 2015). Any participant meeting these inclusion criteria was eligible for the study. Eligible participants who provided informed consent online and validly completed the survey on Qualtrics were compensated \$1.25. The entire data collection spanned approximately 3–4 days.

2.2. Exclusions and Sample Characteristics

Among the obtained 891 responses, 18 participants attempted the survey more than once and hence 47 duplicate responses were excluded. We excluded 150 participants not meeting inclusionary criteria, 122 participants failing the validity checks to ensure attentive responding and comprehension (Meade & Craig, 2012; Thomas & Clifford, 2017), 97 participants missing data on all measures, 11 participants not endorsing any/most distressing trauma on the Life Event Checklist for *DSM-5* (Weathers et al., 2013), and 89 participants missing 30% item-level data on the primary measures. The effective sample of 375 participants ($M_{age} = 35.76$; $SD = 11.08$; 57.10% female) was mostly well-educated ($M = 15.26$ years of schooling, $SD = 2.45$), working full-time (72.50%), White (75.70%), not Hispanic/Latino (85.90%), and a sizeable proportion was married (45.10%). The most prevalent worst traumatic events were transportation accident (17.60%), natural disaster (14.10%), and sexual assault (13.10%). Although a community sample, many participants endorsed being in therapy in the past (43.70%). Further, 45.30% and 15.50% had probable alcohol (Bradley et al., 2003; Bush et al., 1998) and drug use (Skinner, 1982) disorders, respectively. Table 2 provides descriptive information.

2.3. Measures

2.3.1. Life Event Checklist for DSM-5 (LEC-5; Weathers et al., 2013).—This 17-item self-report measure assesses traumatic experiences using a 6-point nominal scale (*happened to me* [1], *witnessed it* [2], *learned about it* [3], *part of my job* [4], *not sure* [5], *doesn't apply* [6]). We considered either one of the first four responses to indicate trauma endorsement.

2.3.2. PTSD Checklist for DSM-5 (PCL-5; Weathers et al., 2013).—This 20-item measure assesses past-month PTSD severity referencing the most distressing trauma endorsed on the LEC-5. Response options range from 0 (*not at all*) to 4 (*extremely*). The PCL-5 has excellent psychometric properties (Wortmann et al., 2016) and good reliability in the current study ($\alpha = .96$).

2.3.3. Alcohol Use and Disorders Identification Test Alcohol Consumption Questions (AUDIT-C; Bush et al., 1998).—This 3-item measure assesses heavy drinking using a 5-point Likert-type scale (Item 1 [frequency of alcohol use]: 0 [*never*] to 4 [*daily or more times a week*]; Item 2 [quantity of alcohol use when drinking]: 0 [*1 or 2*] to 4 [*10 or more*]; Item 3 [frequency of binge drinking]: 0 [*never*] to 4 [*daily or almost daily*]). Summed scores of 3 for females and 4 for males indicate probable alcohol use disorder

(AUD; Bradley et al., 2003; Bush et al., 1998). The AUDIT-C has good reliability ($\alpha = .75$ in current study) and validity (Bush et al., 1998).

2.3.4. Drug Abuse Screening Test (DAST-10; Skinner, 1982).—This 10-item measure assesses drug use and misuse, including occupational or relational problems, illegal activities, and regret. Responses have 1 (*yes*) and 0 (*no*) options. Score of 3 indicates probable drug use disorder (Skinner, 1982). The DAST-10 has adequate psychometric properties ($\alpha = .84$ in current study; Yudko, Lozhkina, & Fouts, 2007).

2.3.5. Posttrauma Risky Behaviors Questionnaire (PRBQ; Contractor, Weiss, Kearns, Caldas, & Dixon-Gordon, in review).—This 16-item measure assesses PTSD's E2 Criterion (post-trauma RSDBs). The first 14 items assess past-month engagement in specific RSDBs, with response options ranging from 0 (*never*) to 4 (*very frequently*). The PRBQ has good reliability ($\alpha = .93$ in the current study) and validity (Contractor et al., in review). We used a 12-item summed score (excluding alcohol and drug use items) as a covariate.

2.3.6. Patient Health Questionnaire-9 (PHQ-9; Kroenke & Spitzer, 2002).—This 9-item measure assesses depression symptoms over the past two weeks. The four response options range from 0 (*not at all*) to 3 (*nearly every day*) (Kroenke, Spitzer, & Williams, 2001). It has good psychometric properties ($\alpha = .91$ in the current study; Kroenke et al., 2001).

2.3.7. Aggression Questionnaire (AQ; Buss & Perry, 1992).—This 29-item measure assesses physical aggression, verbal aggression, anger, and hostility using a 5-point scale (1 [*never or hardly applies to me*] to 5 [*very often applies to me*]). The AQ has adequate psychometric properties and good subscale reliability (α s = .80 - .91 in the current study; Buss & Perry, 1992).

2.4. Statistical Analyses

To identify latent subgroups, we used latent class analyses (LCA; Mplus 8). We treated the PCL-5 (continuous), AUDIT-C (continuous), and DAST-10 (categorical) item-level responses as indicators, and used Maximum Likelihood estimation with robust standard errors (MLR) to address non-normality and to estimate missing data. One-through four-class models were analyzed (e.g., Anderson et al., 2017; Contractor, Roley-Roberts, Lagdon, & Armour, 2017; Tomczyk, Isensee, & Hanewinkel, 2016). The optimal class solution had lowest Bayesian Information Criterion (BIC) and sample-size adjusted BIC (SSABIC) values, an Adjusted Lo–Mendell–Rubin (LMR) Likelihood Ratio Test $p < .05$, a Bootstrapped Likelihood Ratio Test (BLRT) $p < .05$, higher entropy values, parsimony, and conceptual meaning (DiStefano & Kamphaus, 2006; Nylund, Asparouhov, & Muthén, 2007; Nylund, Bellmore, Nishina, & Graham, 2007). A non-significant LMR value for a K -class model indicates an optimal $K-1$ -class model (Nylund, Asparouhov, et al., 2007). A model with a 10-point lower BIC value has a 150:1 likelihood of being the better fitting model (Raftery, 1995).

To identify differences in demographics and trauma types, we compared the obtained classes (independent variable) on demographic variables of age and years of schooling (continuous dependent variables) using one-way ANOVAs, Tukey's post-hoc tests, and partial eta square (η_p^2) effect size estimates (SPSS v.25). We compared the obtained classes on categorical dependent variables of employment status (currently employed vs. not), relationship status (currently married vs. not), income (< vs. \$50,000), ethnicity, race, gender, and trauma types using chi-square tests and Cramer's V effect size estimates (SPSS v.25). Tests were two-tailed ($\alpha = .05$).

We used a three-step approach (multinomial logistic regression, Mplus 8) to estimate the effects of auxiliary/independent variables (PRBQ, PHQ-9, AQ subscales) on class membership (dependent variable) while accounting for misspecification bias (Asparouhov & Muthén, 2014; Vermunt, 2010). We provided odd ratios with confidence intervals and beta coefficients for the results; tests were two-tailed. To account for multiple comparisons, we used a Bonferroni-corrected $p < .008$ (.05/6).

3. Results

Most DAST-10 (excluding 1 and 3) and PRBQ (excluding 1, 4, 6, 8, and 10) items violated normality (skewness > 2 and kurtosis > 7 ; Curran, West, & Finch, 1996). Most fit indices such as LMR and entropy values indicated an optimal three-class solution (see Table 3). Although the BIC and SSABIC values continued to decrease beyond the three-class solution, the decrease was the least between the three- and four-class solutions, supporting the three-class solution. A three-class solution aligns with most LCA research on PTSD and substance use (e.g., Anderson et al., 2017; Contractor, Roley-Roberts, et al., 2017; Tomczyk et al., 2016). Figure 1 provides a graphical depiction of the three-class solution.

We labeled Class 1 ($n = 177$; 47.20%), Class 2 ($n = 128$; 34.13%), and Class 3 ($n = 70$; 18.67%) as Low PTSD/SU, Moderate PTSD/Drug and High Alcohol, and High PTSD/SU respectively. The Low PTSD/SU Class had significantly lower (1) PCL-5 item-scores than other classes, (2) AUDIT-C item-3 (6 drinks in one occasion) score than other classes, (3) AUDIT-C item-2 (number of drinks on a typical day) score than the High PTSD/SU Class, (4) DAST-10 item scores (excluding 3 and 5) than the Moderate PTSD/Drug and High Alcohol Class, and (5) DAST-10 item scores (excluding 3) than the High PTSD/SU Class. At the item-level, the Moderate PTSD/Drug and High Alcohol Class had significantly lower PCL-5 scores, did not differ on AUDIT-C scores, and significantly lower DAST-10 scores (excluding 2, 3, and 4) than the High PTSD/SU Class.

The three classes did not differ significantly in most demographics: proportion of females $\chi^2(2) = .40$, $p = .82$, Cramer's V = .03, males $\chi^2(2) = 1.17$, $p = .56$, Cramer's V = .06, Hispanic/Latino $\chi^2(2) = 2.67$, $p = .26$, Cramer's V = .09, Asians $\chi^2(2) = 2.09$, $p = .35$, Cramer's V = .08, American Indian/Alaskan Natives $\chi^2(2) = 4.36$, $p = .11$, Cramer's V = .11; marital status $\chi^2(2) = .18$, $p = .92$, Cramer's V = .02; income distribution $\chi^2(2) = 6.16$, $p = .05$, Cramer's V = .13; and years of schooling $F(2,372) = .90$, $p = .41$, $\eta_p^2 = .01$. The three classes differed significantly in employment status $\chi^2(2) = 7.47$, $p = .02$, Cramer's V = .14; and in proportion of Whites $\chi^2(2) = 11.19$, $p = .004$, Cramer's V = .17, African Americans

$\chi^2(2) = 6.59, p = .04$, Cramer's $V = .13$, and Native Hawaiian/Pacific Islanders $\chi^2(2) = 8.76, p = .01$, Cramer's $V = .15$. The three classes differed significantly in age $F(2,371) = 9.62, p < .001, \eta_p^2 = .05$; Low PTSD/SU Class was significantly younger than the Moderate PTSD/Drug and High Alcohol Class ($p < .001$) and High PTSD/SU Class ($p = .004$). Referencing trauma types, the three classes significantly differed in endorsement of exposure to toxic substances, $\chi^2(2) = 7.20, p = .03$, Cramer's $V = .14$, sexual assault $\chi^2(2) = 9.83, p = .01$, Cramer's $V = .16$, other unwanted/uncomfortable sexual experiences $\chi^2(2) = 6.23, p = .04$, Cramer's $V = .13$, severe human suffering $\chi^2(2) = 8.33, p = .02$, Cramer's $V = .15$, and causing serious injury, harm, or death $\chi^2(2) = 7.39, p = .03$, Cramer's $V = .14$.

Table 4 indicates results of the three-step approach analyses. Results indicated that RSDBs ($B = .19, SE = .05, p < .001$) and depression ($B = .20, SE = .05, p < .001$) were significant predictors of the Moderate PTSD/Drug and High Alcohol Class versus the Low PTSD/SU Class; and RSDBs ($B = .17, SE = .05, p = .001$) and depression ($B = .44, SE = .06, p < .001$) were significant predictors of the High versus Low PTSD/SU Classes. The High PTSD/SU Class and Moderate PTSD/Drug and High Alcohol Class reported greater depression and more RSDBs than the Low PTSD/SU Class. Depression ($B = .24, SE = .05, p < .001$) was a significant predictor of the High PTSD/SU Class versus the Moderate PTSD/Drug and High Alcohol Class, with average depression scores among the High Class nearly twice that of the Moderate Class.

4. Discussion

Study findings improve our understanding of PTSD-SU co-occurrence patterns. As hypothesized, we found three meaningful subgroups characterized by (1) low PTSD symptoms and SU, (2) moderate PTSD symptoms/drug use and high alcohol use, and (3) high PTSD symptoms and SU. Our results align with person-centered research on PTSD (Contractor et al., 2016; Contractor, Caldas, Weiss, et al., 2018; Contractor, Elhai, et al., 2015; Contractor, Roley-Roberts, et al., 2017) and SU (Connor et al., 2014; Tomczyk et al., 2016); these studies have generally yielded three-to-four-class solutions. Our subgroups predominantly differed in symptom severity rather than type, which is relatively more common in PTSD (e.g., Contractor, Caldas, Weiss, et al., 2018; Hruska, Irish, Pacella, Sledjeski, & Delahanty, 2014) compared to SU research (e.g., Carlson, Wang, Falck, & Siegal, 2005). Thus, it is possible that PTSD symptoms may be driving the obtained pattern of results.

As expected, individuals in the High PTSD/SU Class reported higher PTSD and drug use compared to other classes. The High PTSD/SU Class members may have used more drugs and alcohol to cope with their more severe PTSD symptoms (Stewart et al., 1998) and drug dependence/withdrawal symptoms (Connor et al., 2014; Darke, Duflou, Torok, & Prolov, 2013). Importantly, likely bidirectional relations between PTSD and SU (e.g., "kindling," or exacerbation of symptoms as a function of use; Jacobson, Southwick, & Kosten, 2001) may explain our findings. For instance, the High PTSD-SU Class individuals may experience functional impairment due to SU, which in turn may contribute to increased PTSD-SU severity.

Moreover, at the item-level, few class differences were detected for alcohol use. Specifically, while individuals in the Low PTSD/SU Class reported fewer typical number of drinks consumed (compared to other Classes) and less binge drinking (compared to the High PTSD/SU Class), no other item-level differences were detected between the Moderate PTSD/Drug and High Alcohol Class and the High PTSD/SU Class. Given that alcohol use is relatively normative, individuals with a range of PTSD severity may use alcohol, whereas drug use may better differentiate subgroups characterized by higher PTSD severity. Alternatively, individuals may use different substances (drug vs. alcohol) to manage different types/levels of PTSD symptoms (Simons, Gaher, Jacobs, Meyer, & Johnson-Jimenez, 2005). Finally, personality traits (Kotov, Gamez, Schmidt, & Watson, 2010) or environmental risk factors (McLeod et al., 2001) may explain the obtained subgroup structure in our study.

Notably, the three class-solution had construct validity (unique relations with RSDBs, depression, and aggression). As hypothesized, higher severity classes were characterized by greater RSDBs and depression symptoms. These findings align with models suggesting that PTSD (Bonde et al., 2016) and SU (Currie et al., 2005) co-occur with depression via causal links or shared etiological risk factors (Strander, Thomsen, & Highfill-McRoy, 2014; Swendsen & Merikangas, 2000). Further, supporting evidence indicates that individuals with co-occurring PTSD and SU (Tull, Weiss, & McDermott, 2015) and experiencing traumatic events may engage in RSDBs to regulate affect (Marshall-Berenz, Vujanovic, & MacPherson, 2011), and SU (one RSDB) may increase future RSDBs (Cooper, 2002). Finally, aggression facets were not significant class membership predictors. Research suggests the presence of heightened levels of anger/hostility among individuals with subthreshold (vs. no) PTSD (Jakupcak et al., 2007); potentially anger/hostility may have been equally heightened among all subgroups. Notably, although the overall sample most frequently endorsed transportation accident, natural disaster, and sexual assault consistent with past research (Kilpatrick et al., 2013), some differences in trauma types across classes could have contributed to study findings. For instance, the High PTSD/SU Class reported more sexual assault-related events; such interpersonal traumas have been shown to relate to greater psychopathology (Contractor, Caldas, Fletcher, Shea, & Armour, 2018).

Our study results may assist clinicians in identifying individuals at risk for co-occurring PTSD-SU and its negative sequelae. For instance, PTSD and SU were found to co-occur within the classes, highlighting the need to assess PTSD symptoms among SU populations (e.g., Brady, Killeen, Saladin, Dansky, & Becker, 1994) and SU among populations with PTSD (e.g., Brown, Stout, & Mueller, 1999). Relatedly, study results also highlight the importance of acknowledging/addressing heterogeneity in substances co-occurring with PTSD symptom severity; drug (vs. alcohol) use paralleled PTSD severity levels. Further, remedial and preventive treatments should prioritize individuals with greater PTSD symptoms and SU given their greater impairment. Moreover, results suggest the need to address the PTSD-SU co-occurrence in treatment consistent with existing research (Brady, Back, & Coffey, 2004; Roberts, Roberts, Jones, & Bisson, 2015). Finally, use of LCA extends previous work on the PTSD-SU co-occurrence by underscoring the utility of individualized treatment approaches for distinct subgroups of individuals that may otherwise be classified into one group and treated in a similar fashion. For example, our findings

suggest that it may be particularly important to target depression and RSDBs amongst individuals reporting higher PTSD/SU compared to individuals in other classes.

Strengths of the current study include the use of a large sample of trauma-exposed individuals in the general population, use of a sophisticated analytic approach, evaluation of alcohol consumption and drug (mis)use, and addressing a research question with public health and clinical significance. Nonetheless, we should consider some limitations. First, the cross-sectional nature of the data precludes determination of the precise nature and direction of the PTSD-SU co-occurrence. Second, this study relied on self-report, which may be influenced by one's willingness/ability to report accurately. Third, our alcohol use measure only assessed consumption. Alcohol consumption is not always problematic, such that its consequences vary as a function of contextual factors (e.g., gender, country of origin; Erol & Karpyak, 2015). Therefore, research in this area would benefit from examination of the consequences of alcohol consumption, as was the case for our measure of drug (mis)use. Fourth, the use of a convenience sampling methodology may have introduced selection bias (e.g., restricted to individuals with computer/survey access abilities) reducing sample representativeness (Fricker, 2008). Fifth, our exclusions resulted in a final sample less than 50% of the original sample; although these exclusions enhanced the results' validity, they may have adversely influenced sample representativeness and generalizability of findings. Sixth, future research is needed to better understand the nature and correlates of the identified classes, including treatment initiation, history, and outcome, as well as substance use type, consumption level, and consequences. Despite study limitations, the present study is the first of its kind to utilize a person-centered approach to examine and extend our knowledge of PTSD-SU co-occurrence patterns using item-level data. Exploring the relation between PTSD-SU typologies and treatment indicators/outcomes needs further research.

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Figure 1.

Latent classes of participants based on endorsed responses to PTSD and SU items

Note. PTSD = posttraumatic stress disorder; SU = substance use; PCL-5 = PTSD Checklist for DSM-5; AUDIT-C = Alcohol Use and Disorders Identification Test Alcohol

Consumption Questions; DAST-10 = Drug Abuse Screening Test; PCL-5-1 = intrusive thoughts; PCL-5-2 = recurrent nightmares; PCL-5-3 = flashbacks; PCL-5-4 = emotional reactivity; PCL-5-5 = physiological reactivity; PCL-5-6 = avoidance of thoughts; PCL-5-7 = avoidance of external reminders; PCL-5-8 = memory impairment; PCL-5-9 = negative beliefs; PCL-5-10 = blame of self/others; PCL-5-11 = negative trauma-related emotions; PCL-5-12 = lack of interest; PCL-5-13 = detachment; PCL-5-14 = restricted range of affect; PCL-5-15 = irritability/anger; PCL-5-16 = reckless and self-destructive behaviors; PCL-5-17 = hypervigilance; PCL-5-18 = startle responses; PCL-5-19 = concentration difficulties; PCL-5-20 = sleep difficulties; AUDIT-C-1 = frequency of alcohol use; AUDIT-C-2 = number of drinks on a typical day; AUDIT-C-3 = frequency of 6 or more drinks on one occasion; DAST-10-1 = use of drugs (not for medical reasons); DAST-10-2 = abusing more than one drug at a time; DAST-10-3 = unable to stop drugs when desired; DAST-10-4 = blackouts/flashbacks due to drug use; DAST-10-5 = feel bad/guilty of drug use; DAST-10-6 = spouse/parents complain of one's drug use; DAST-10-7 = neglect of family due to drug use; DAST-10-8 = illegal activities due to drug use; DAST-10-9 = withdrawal symptoms (stop drugs); DAST-10-10 = medical problems due to drug use; Class 1 = Low PTSD/SU; Class 2 = Moderate PTSD/Drug and High Alcohol; Class 3 = High PTSD/SU.

Table 1. Studies using person-centered approaches to examine alcohol/drug and their comorbid mental health indicators' typologies

Study	Sample	Alcohol Use Typologies	Class Solution
Jackson et al. (2014)	5018 New Zealand secondary schools students (current drinkers)	Four-class solution of drinking patterns: low risk; moderate risk; high risk; very high risk	
Jacob, Blonigen, Koenig, Wachsmuth, and Price (2010)	839 participants from the Vietnam Era Twin Registry	Four-class solution of developmental trajectories of alcohol use: severe chronic alcoholics; severe non-chronic alcoholics; late onset alcoholics; young-adult alcoholics	
Cranford, Krentzman, Mowbray, and Robinson (2014)	364 adults with alcohol dependence	Five-class solution of drinking behavior trajectories: moderate baseline-slow decline; heavy baseline-stable abstinent; heavy baseline-slow decline; heaviest baseline-slow decline; heaviest baseline-stable heavy	
Mowbray, Glass, and Grinnell-Davis (2015)	257 participants of the NESARC	Four-class solution of treatment use patterns for alcohol use: multiservice users; private professional service users; alcoholics anonymous and specialty addiction service users; alcoholics anonymous users only	
Schuler, Puttiah, Mojtabai, and Crum (2015)	1053 participants from the NESARC	Two-class solution of perceived barriers to seeking alcohol treatment: low- and high-barriers classes	
Drug Use Typologies			
Moss, Goldstein, Chen, and Yi (2015)	Waves 1 ($n = 43,093$) and 2 ($n = 34,653$) of the NESARC	Four-class solution of concurrent substance use: alcohol only; alcohol and tobacco only; alcohol, tobacco and cannabis; alcohol, tobacco, cannabis, cocaine, and other illicit drugs	
Carlson et al. (2005)	402 recent ecstasy users in Ohio	Three-class solution of polysubstance use among individuals using ecstasy: limited, moderate, and wide range classes referencing increasing extent of polydrug use	
Lynskey et al. (2006)	6265 Australian twins	Five-class solution of lifetime illicit drug use: low risk; moderate risk; high rates of cocaine, stimulant and hallucinogen use; high rates of sedative and opioid use; high probabilities for all drug use	
Substance Use and Comorbid Mental Health Indicators			
Vermeulen-Smit, Ten Have, Van Laar, and De Graaf (2015)	5303 participants from the second wave of the Netherlands Mental Health Survey and Incidence Study	Four-class solution of health risk behavior indicators: most healthy; smokers, moderate drinkers, inactive, unhealthy diet; smokers, heavy episodic drinkers, active, unhealthy diet; smokers, frequent heavy drinkers, active, low fruit	
Weich et al. (2011)	7325 participants from the 2007 Adult Psychiatric Morbidity Survey	Four-class solution of psychiatric comorbidity: unaffected; co-thymia; highly comorbid, addictions	
Vaughn et al. (2011)	43,093 participants from the 2001–2002 NESARC	Four-class solution of lifetime externalizing behaviors: normative; low substance use/high antisocial behaviors; high substance use/moderate antisocial behaviors; severe	
Kessler, Chiu, Demler, and Walters (2005)	9282 participants from the US National Comorbidity Survey Replication Study	Seven-class solution of psychiatric comorbidity: unaffected; internalizing disorders; externalizing disorders; comorbid internalizing disorders, internalizing and/or externalizing disorders with comorbid social phobia and attention-deficit hyperactivity disorder; highly comorbid major depressive episodes; highly comorbid bipolar disorder	
Wallen, Park, Krumlauf, and Brooks (2018)	164 treatment-seeking individuals with alcohol use disorder	Three-class solution of psychiatric comorbidity: sleep disturbance; sleep disturbance, anxiety and depression; and sleep disturbance, anxiety, depression, and PTSD.	

Note. NESARC = National Epidemiologic Survey on Alcohol and Related Conditions; PTSD = posttraumatic stress disorder.

Table 2.

Descriptive information on demographics constructs for the entire sample and each latent class.

	Full Sample (<i>n</i> = 375)	Low PTSD/SU (<i>n</i> = 177)	Moderate PTSD/Drug and High Alcohol (<i>n</i> = 128)	High PTSD/SU (<i>n</i> = 70)
	Mean (<i>SD</i>)			
Age	35.76 (11.08)	38.36 (11.97)	33.48 (9.62)	33.39 (9.82)
Years of schooling	15.26 (2.45)	15.29 (2.26)	15.06 (2.61)	15.54 (2.60)
PCL-5 score	24.63 (20.21)	7.14 (5.83)	31.08 (7.51)	57.07 (9.67)
PHQ-9 score	7.16 (6.46)	3.14 (3.49)	8.16 (5.13)	15.53 (5.66)
Physical aggression score	23.55 (10.42)	20.88 (8.05)	23.80 (10.48)	29.86 (12.74)
Verbal aggression score	15.04 (6.67)	13.02 (5.60)	15.97 (6.11)	18.49 (8.29)
Anger score	19.17 (8.57)	16.15 (6.00)	19.99 (8.61)	25.29 (10.34)
Hostility score	23.36 (12.24)	18.13 (9.84)	24.82 (11.50)	33.81 (11.67)
AUDIT-C score	3.06 (2.54)	2.65 (2.16)	3.28 (2.80)	3.70 (2.78)
DAST-10 score	1.23 (1.97)	0.66 (1.03)	1.37 (2.09)	2.46 (2.84)
	<i>n</i> (% within column) *			
Gender				
Female	214 (57.10%)	98 (55.40%)	75 (58.60%)	41 (58.60%)
Male	155 (41.30%)	78 (44.10%)	51 (39.80%)	26 (37.10%)
Female to Male	3 (.80%)	1 (.60%)	1 (.80%)	1 (1.40%)
Male to Female	1 (.30%)	0 (0%)	1 (.80%)	0 (0%)
Other	2 (.50%)	0 (0%)	0 (0%)	2 (2.90%)
Employment Status				
Part time	55 (14.70%)	26 (14.70%)	16 (12.50%)	13 (18.60%)
Full time	272 (72.50%)	120 (67.80%)	99 (77.30%)	53 (75.70%)
Unemployed	29 (7.70%)	18 (10.20%)	9 (7%)	2 (2.90%)
Unemployed Student	7 (1.90%)	4 (2.30%)	2 (1.60%)	1 (1.40%)
Retired	12 (3.20%)	9 (5.10%)	2 (1.60%)	1 (1.40%)
Relationship Status				
Not dating	58 (15.50%)	27 (15.30%)	20 (15.60%)	11 (15.70%)
Causally dating	27 (7.20%)	11 (6.20%)	8 (6.30%)	8 (11.40%)
Seriously dating	91 (24.30%)	43 (24.30%)	33 (25.80%)	15 (21.40%)

	Full Sample (n = 375)	Low PTSD/SU (n = 177)	Moderate PTSD/Drug and High Alcohol (n = 128)	High PTSD/SU (n = 70)
Married	169 (45.10%)	81 (45.80%)	58 (45.30%)	30 (21.40%)
Divorced	17 (4.50%)	7 (4.00%)	7 (5.50%)	3 (4.30%)
Separated	6 (1.60%)	4 (2.30%)	1 (.80%)	1 (1.40%)
Widowed	7 (1.90%)	4 (2.30%)	1 (.80%)	2 (2.90%)
Racial Status (could endorse multiple responses)				
White	284 (75.70%)	147 (83.10%)	92 (71.90%)	45 (64.30%)
Asian	41 (10.90%)	15 (8.50%)	17 (13.30%)	9 (12.90%)
African American	39 (10.40%)	11 (6.20%)	17 (13.30%)	11 (15.70%)
American Indian or Alaskan Native	19 (5.10%)	7 (4%)	5 (3.90%)	7 (10%)
Native Hawaiian/other Pacific Islander	2 (.50%)	0 (0%)	0 (0%)	2 (2.90%)
Unknown	7 (1.90%)	4 (2.30%)	3 (2.30%)	0 (0%)
Ethnicity				
Hispanic or Latino	47 (12.50%)	17 (9.60%)	19 (14.80%)	11 (15.70%)
Not Hispanic or Latino	322 (85.90%)	157 (88.70%)	108 (84.40%)	57 (81.40%)
Unknown	6 (1.60%)	3 (1.70%)	1 (.80%)	2 (2.90%)
Income				
Less than \$15,000	35 (9.30%)	12 (6.80%)	14 (10.90%)	9 (12.90%)
\$15,000 - \$24,999	52 (13.90%)	23 (13%)	18 (14.10%)	11 (15.70%)
\$25,000 - \$34,999	57 (15.20%)	20 (11.30%)	21 (16.40%)	16 (22.90%)
\$35,000 - \$49,999	48 (12.80%)	24 (13.60%)	18 (14.10%)	6 (8.60%)
\$50,000 - \$64,999	71 (18.90%)	37 (20.90%)	20 (15.60%)	14 (20%)
\$65,000 - \$79,999	33 (8.80%)	19 (10.70%)	9 (7%)	5 (7.10%)
\$80,000 and higher	79 (21.10%)	42 (23.70%)	28 (21.90%)	9 (12.90%)
Index traumatic events endorsed on the LEC-5				
Natural disaster	53 (14.10%)	23 (13%)	18 (14.10%)	12 (17.10%)
Fire/explosion	19 (5.10%)	10 (5.60%)	4 (3.10%)	5 (7.10%)
Transportation accident	66 (17.60%)	35 (19.80%)	25 (19.50%)	6 (8.60%)
Serious accident at work, home, or during recreational activity	10 (2.70%)	6 (3.40%)	3 (2.30%)	1 (1.40%)
Exposure to a toxic substance	2 (.50%)	1 (.60%)	0 (0%)	1 (1.40%)
Physical assault	33 (8.80%)	14 (7.90%)	15 (11.70%)	4 (5.70%)
Assault with a weapon	12 (3.20%)	7 (4%)	1 (.80%)	4 (5.70%)

	Full Sample (n = 375)	Low PTSD/SU (n = 177)	Moderate PTSD/Drug and High Alcohol (n = 128)	High PTSD/SU (n = 70)
Sexual assault	49 (13.10%)	19 (10.70%)	16 (12.50%)	14 (20%)
Other unwanted/uncomfortable sexual experience	10 (2.70%)	1 (.60%)	6 (4.70%)	3 (4.30%)
Combat or Exposure to a War-zone	3 (.80%)	1 (.60%)	2 (1.60%)	0 (0%)
Captivity	2 (.50%)	1 (.60%)	1 (.80%)	0 (0%)
Life-threatening illness/injury	30 (8%)	17 (9.60%)	9 (7%)	4 (5.70%)
Severe human suffering	4 (1.10%)	3 (1.70%)	0 (0%)	1 (1.40%)
Sudden violent death	26 (6.90%)	16 (9%)	8 (6.30%)	2 (2.90%)
Sudden accidental death	25 (6.70%)	12 (6.80%)	9 (7%)	4 (5.70%)
Serious injury, harm, or death you caused	7 (1.90%)	4 (2.30%)	0 (0%)	3 (4.30%)
Any other stressful event	21 (5.60%)	6 (3.40%)	10 (7.80%)	5 (7.10%)
Prefer not to respond	3 (.80%)	1 (.60%)	1 (.80%)	1 (1.40%)
Received treatment for a mental health or emotional problem (could endorse multiple responses)				
Currently in therapy	35 (9.33%)	8 (4.50%)	9 (7%)	18 (25.70%)
Been in therapy in the past	164 (43.70%)	64 (36.20%)	66 (51.60%)	34 (48.60%)
Currently on medication	65 (17.30%)	28 (15.80%)	17 (13.30%)	20 (28.60%)
Been on medication in the past	73 (19.50%)	27 (15.30%)	28 (21.90%)	18 (25.70%)
Never received treatment	145 (38.70%)	83 (46.90%)	44 (34.40%)	18 (25.70%)

Note.

* All reported percentages are *valid percentages* to account for missing data; PCL-5 = PTSD Checklist for DSM-5; PHQ-9 = Patient Health Questionnaire-9; AUDIT-C = Alcohol Use and Disorders Identification Test Alcohol Consumption Questions; DAST-10 = Drug Abuse Screening Test; LEC-5 = the Life Events Checklist for DSM-5.

Table 3.

Results of the latent class analyses

Model	AIC	BIC	SSABIC	Entropy	Adjusted Lo-Mendell-Rubin (p)	BLRT p value
1 class	31169.759	31389.667	31211.994			
2 class	27114.133	27467.556	27182.010	.98	4103.265 ($p < .001$)	$p < .001$
3 class	26064.983	26551.921	26158.502	.97	1111.634 ($p = .0001$)	$p < .001$
4 class	25615.976	26236.430	25735.138	.97	514.454 ($p = .23$)	$p < .001$

Note. AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion; SSABIC = sample-size adjusted BIC; BLRT = Bootstrapped Likelihood Ratio Test.

Table 4.

Results of multinomial logistic regression analyses

	Moderate PTSD/Drug and High Alcohol vs. Low PTSD/SU [#]	High PTSD/SU vs. Low PTSD/SU [#]	High PTSD/SU vs. Moderate PTSD/Drug and High Alcohol [#]
	OR [95% CI]		
Depression	1.22 [1.11, 1.34] [*]	1.55 [1.37, 1.75] [*]	1.27 [1.15, 1.39] [*]
Physical aggression	.95 [.90, .99] ^{p = .04}	.98 [.92, 1.05]	1.03 [.98, 1.09]
Verbal aggression	1.07 [1.00, 1.14] ^{p = .05}	1.07 [.97, 1.17]	1.00 [.92, 1.08]
Anger	1.02 [.96, 1.09]	1.02 [.93, 1.12]	1.00 [.93, 1.08]
Hostility	1.00 [.96, 1.04]	1.01 [.96, 1.06]	1.01 [.97, 1.05]
RSDBs	1.20 [1.10, 1.32] [*]	1.19 [1.08, 1.30] ^{**}	1.00 [.94, 1.03]

Note. PTSD = posttraumatic stress disorder; OR = odds ratio; CI = confidence interval; RSDB = Reckless and self-destructive behaviors;

^{*} $p < .001$;

^{**} $p = .001$;

[#] = the reference class.