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Abstract

This study investigated the co-occurrence of posttraumatic stress disorder (PTSD) and substance use disorders (SUDs) in a sample ($N = 668$) recruited for personality disorders and followed longitudinally as part of the Collaborative Longitudinal Personality Disorders Study. The study both examined rates of co-occurring disorders at baseline and temporal relationships between PTSD and substance use disorders over 4 years. Subjects with a lifetime history of PTSD at baseline had significantly higher rates of SUDs (both alcohol and drug) than subjects without PTSD. Latent class growth analysis, a relatively novel approach used to analyze trajectories and

identify homogeneous subgroups of participant on the basis of probabilities of PTSD and SUD over time, identified 6 classes, which were compared with respect to a set of functioning and personality variables. The most consistent differences were observed between the group that displayed low probabilities of both SUD and PTSD and the group that displayed high probabilities of both.

Keywords

PTSD; substance abuse; comorbidity; longitudinal

A high degree of comorbidity has been observed between posttraumatic stress disorder (PTSD) and substance use disorders (SUDs). Among persons with PTSD, findings from the National Comorbidity Survey (NCS) suggest lifetime comorbidity rates of 51.9% for alcohol use disorders (AUDs; including alcohol abuse and alcohol dependence) and 34.5% for drug use disorders (DUDs; abuse and dependence) among men. For women, the NCS reported lifetime comorbidity rates of 27.9% for AUDs and 26.9% for DUDs (Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995). Among treatment-seeking samples, rates of comorbid substance abuse are even higher (Keane & Wolfe, 1990; Steindl, Young, Creamer, & Crompton, 2003). Thus, at a broad level, the diagnosis of PTSD is clearly associated with increased risk of SUDs (Hien, Cohen, & Campbell, 2005).

The evidence also suggests that persons with both PTSD and SUD exhibit a more severe and persistent course of both disorders, demonstrating more substance-related problems, greater psychological distress (Najavits, Weiss, & Shaw, 1999), and worse psychosocial adjustment (Riggs, Rukstalis, Volpicelli, Kalmanson, & Foa, 2003). Patients with comorbid PTSD-AUD tend to rely on maladaptive coping styles more so than alcohol abusers with other psychiatric disorders, and they tend to show less improvement in this domain than patients with AUDs alone following traditional substance abuse treatment (Ouimette, Finney, & Moos, 1999). Some research suggests that a diagnosis of substance abuse is associated with increased treatment dropout (Van Minnen, Arntz, & Keijsers, 2002) and worse outcomes for PTSD treatment (Perconte & Griger, 1991), and that PTSD symptoms are associated with poorer response to substance abuse treatment (Ouimette, Brown, & Najavits, 1998) and shorter latency to relapse among substance abusers (Brown, Stout, & Mueller, 1996).

Several studies have investigated longitudinal relationships between PTSD and SUD (e.g., Najavits et al., 2007; Norman, Tate, Anderson, & Brown, 2007). Typically, these studies have focused on the effect of a specific treatment on PTSD or SUD symptoms across 6- to 12-month timeframes. One study examined the relationship between PTSD symptoms and the contexts leading to relapse to substance use and found that higher levels of PTSD were associated with increased risk of relapse in response to negative affect (Norman et al., 2007). Another study investigated whether cocaine-dependent patients with PTSD fared worse than those without PTSD over a 6-month interval following substance abuse treatment. That study found that PTSD-SUD patients demonstrated less improvement following treatment relative to SUD-only patients (Najavits et al., 2008). A third study followed SUD patients for 6 months after inpatient treatment and found that for persons with PTSD, changes in

PTSD symptoms were linked to risk of relapse to alcohol, but baseline PTSD status alone was not predictive of outcome (Read, Brown, & Kahler, 2004). There are no studies reporting data over a longer time period, however, and no studies reporting on longitudinal co-occurrence of PTSD and SUD within a heterogeneous psychiatric sample.

The current study was an exploratory investigation of the longitudinal trajectories of PTSD-SUD co-occurrence. The goal of the present study was to evaluate the relationships between PTSD and SUD longitudinally, using data from the Collaborative Longitudinal Personality Disorders Study (CLPS), a multisite, longitudinal study of personality pathology that is primarily concerned with the longitudinal course of four personality disorders: schizotypal, borderline, avoidant, and obsessive-compulsive.

Exploring Heterogeneity in Trajectories of Co-Occurrence

Innovations in statistical procedures over the past decade have allowed for increasingly complex analyses using longitudinal data. Aggregated data provide important information about trends that exist across whole samples, yet they may obscure patterns occurring for subgroups of participants. Recently, growth mixture modeling has provided a novel approach to identifying trajectories of substance abuse over time in several studies (e.g., Jackson & Sher, 2008; Jackson, Sher, & Schulenberg, 2005). For example, a recent study of alcohol relapse patterns using growth mixture modeling uncovered three subgroups of participants characterized by different trajectories with distinct clinical implications (Witkiewitz & Masyn, 2008).

Recognizing that persons with co-occurring PTSD and SUD are a subset of the populations of persons with PTSD and those with SUD, we hypothesized that our latent class growth analyses would generate at least four groups on the basis of trajectory patterns: high SUD–high PTSD, low SUD–low PTSD, high SUD–low PTSD, and low SUD–high PTSD. And we allowed for the possibility that other, more complex solutions would provide a better fit to the data and would provide a conceptual advantage to describing longitudinal patterns of cooccurrence. To explore the possibility that distinct patterns of co-occurrence may be masked by aggregated data, our a priori plan was to select the solution that resulted in the largest number of classes that still provided a good fit to the data.

We conducted a series of analyses to permit an understanding of meaningful differences between the identified classes. Specifically, we were interested in associations with functioning, given the literature suggesting that patients with co-occurring PTSD and SUD demonstrate worse functioning than those with either diagnosis alone. We were also interested in describing the classes in terms of the three broad personality dimensions of positive temperament (PT), negative temperament (NT), and disinhibition (DIS). These dimensions have emerged as a triad that seems to undergird much of the variability in psychopathology. A recent study also investigated the role of these traits in the relationship between PTSD and substance abuse (Miller et al., 2006) and found that the relationship between PTSD and substance abuse seemed to be fully mediated by NT and DIS. We examined the pattern of these traits longitudinally, by class, to investigate whether trajectories of PTSD-SUD cooccurrence mirrored changes in broad traits over time.

Method

Participants

The aims, background, design, and methods of the larger CLPS have been described elsewhere (Gunderson et al., 2000). Participants were recruited from clinical sites in four north-eastern cities: Boston, Providence, New Haven, and New York. Exclusion criteria included current psychosis, current intoxication or with-drawal, IQ less than 85, age younger than 18 or older than 45 years, or confusional state due to organic disorders. Participants were selected on the basis of meeting criteria for one of the four personality disorders of interest (schizotypal, borderline, avoidant, or obsessive–compulsive) or for major depressive disorder without a personality disorder. Participants provided written informed consent prior to participating. There were 668 participants in the sample, including 245 men and 423 women. A majority of participants were Caucasian ($n = 506$, 75.7%), with African American participants making up the largest minority group ($n = 80$, 12.0%), followed by Hispanic participants ($n = 62$, 9.3%).

Procedure

On meeting inclusion criteria and giving informed consent, participants completed a baseline clinical interview. At baseline, participants were assessed for the full spectrum of Diagnostic and Statistical Manual of Mental Disorders (4th ed.; *DSM–IV*) Axis I and Axis II diagnoses using the Structured Clinical Interview for *DSM–IV* (SCID) and the Diagnostic Interview for *DSM–IV* Personality Disorders (DIPD–IV) and completed self-report measures. Participants completed follow-up assessments at 6 months and 12 months after baseline and yearly thereafter. Data gathered over a 5-year period (baseline and four yearly follow-ups) are included in this investigation.

Measures

Psychopathology—Diagnoses were assigned using structured interviews. At baseline, personality disorder diagnoses were made using the DIPD–IV (Zanarini, Frankenburg, Sickel, & Yong, 1996). Baseline Axis I diagnoses were made using the SCID (First, Gibbon, Spitzer, & Williams, 1996). The current report includes data collected over 4 years. An investigation of the reliability of baseline interviews (Zanarini et al., 2000) yielded interrater kappa coefficients in the excellent range for the diagnoses relevant to the present investigation: PTSD, $\kappa = 0.88$; AUD, $\kappa = 1.0$; and DUDs, $\kappa = 1.0$. Test–retest reliability coefficients were also in the excellent range for PTSD ($\kappa = 0.78$), AUD ($\kappa = 0.77$), and DUD ($\kappa = 0.76$).

The course of all co-occurring Axis I disorders was assessed at each follow-up interview using the Longitudinal Interval Follow-up Evaluation (LIFE; Keller et al., 1987). Using the LIFE, interviewers make psychiatric status ratings on a 3-point scale (3 = *full criteria for disorder met*, 2 = *partial criteria met*, 1 = *no criteria met*) for all diagnoses (except major depressive disorder, which is rated on a 6-point scale) for each week of the follow-up interval. We used point prevalence of each diagnosis of interest (using a dichotomous present or absent rating) at each year from baseline through the 4-year follow-up interview. For longitudinal analyses, we collapsed AUDs and DUDs into a broad category of SUDs.

Psychosocial functioning—Global assessment of functioning (GAF) was rated by interviewers following the diagnostic interview. Interviewers also rated psychosocial functioning across several domains, including interpersonal, recreational, and life satisfaction using the LIFE (Keller et al., 1987). For each domain, raters use a 5-point severity scale ranging from 1 (*no impairment*) to 5 (*severe impairment and very poor functioning*).

Personality variables—The three broad trait dimensions of PT, NT, and DIS were assessed using the Schedule for Nonadaptive and Adaptive Personality (SNAP; Clark, 1993). The SNAP is a 375-item (items are rated true or false) self-report instrument assessing these three higher order temperament dimensions as well as 12 personality traits and 13 diagnoses. SNAP data collected at baseline and Years 1, 2, and 3 were analyzed in the current study. A previous manuscript from the CLPS project reported on reliability findings for the SNAP in this sample, including a median internal consistency alpha of .89 for the three higher order traits (Morey et al., 2003).

Analytic Approach

To simultaneously estimate patterns of change in PTSD and SUD diagnoses over time, we used latent class growth analysis (LCGA). LCGA is a type of mixture modeling procedure designed for use with categorical manifest variables (e.g., diagnoses) measured at multiple time points (Jackson & Sher, 2008; L. Muthén & Muthén, 1998–2006). It is a person-centered analytic tool for identifying subgroups of individuals with distinct trajectories (B. O. Muthén, 2001). For this study, it provided a method for investigating whether subgroups of individuals have distinct trajectories of PTSD and SUD over time. The LCGAs were fit using the statistical package Mplus Version 3.14 (L. Muthén & Muthén, 1998–2006). Consistent with previous work, “models were estimated with automatically generated random start values using full information maximum likelihood, which assumes data are missing at random” (Jackson & Sher, 2008, p. 202). To determine the fewest number of subgroups (classes) that best characterized change patterns in SUD and PTSD diagnoses over time, we evaluated several fit statistics, including the Akaike information criteria (AIC), Bayesian information criteria (BIC), sample-size adjusted BIC (SABIC), and the Lo–Mendell–Rubin likelihood ratio test (LMR LRT; Lo, Mendell, & Rubin, 2001). It also has been recommended that the theoretical/substantive meaning of solutions with different numbers of classes be used in conjunction with fit statistics to guide selection of the best-fitting model (Muthén, 2003).

Results

At baseline, 212 participants (30% of the full sample) met lifetime (current or past) criteria for PTSD on the basis of structured interviews. A total of 357 participants (50.9% of the full sample) reported a history of SUD. This included 283 participants (40.4%) meeting lifetime criteria for AUD, 270 participants (37.0%) meeting lifetime criteria for DUDs, and 185 (26.4%) meeting criteria for both AUD and DUD. Compared with participants without PTSD, those with PTSD evidenced a significantly higher rate of SUDs, such that 61.8% ($n = 131$) of those with PTSD and 46.2% ($n = 226$) of those without PTSD had an SUD diagnosis

(Pearson $\chi^2 = 14.4, p < .01$). Specifically, 48.1% ($n = 102$) of those with PTSD and 37.0% ($n = 181$) of those without PTSD met criteria for AUD (Pearson $\chi^2 = 7.57, p < .01$), and 45.8% ($n = 100$) of those with PTSD compared with 33.1% ($n = 162$) of those without PTSD met criteria for DUD (Pearson $\chi^2 = 10.12, p < .01$).

Latent Class Growth Analyses

Preliminary analyses—The first step in conducting the LCGAs was determining the best way of modeling change in PTSD and SUD over time. To do this, we compared three one-class latent class growth models that each represented a different change function (i.e., linear, quadratic, and cubic). For the linear model, four latent factors were defined: one representing initial (baseline) levels for SUD and one representing initial (baseline) levels for PTSD (i.e., intercepts) along with one representing linear change in PTSD and one representing linear change in SUD over time (i.e., slopes). Factor loadings for the intercepts for the five observed measures of both PTSD and SUD were fixed to 1; factor loadings for the slopes were set to 0, 1, 2, 3, 4 to reflect intervals between assessment periods in the study. For the quadratic model, two additional latent variables were added to the linear model. They represented a quadratic pattern of change for PTSD and SUD (factor loadings fixed to 0, 1, 4, 9, 16 for both latent variables). Finally, for the cubic model, two additional latent variables were added to the quadratic model. They represented a cubic pattern of change for PTSD and SUD (factor loadings fixed to 0, 1, 16, 81, 256 for both latent variables). Findings indicated that the quadratic model seemed to provide the best fit to the data. Specifically, the quadratic model provided a better fit than the linear model

($\chi^2_{\text{Difference}} = 28.30, p < .05$), and the addition of the cubic latent variables did not improve model fit compared with the quadratic model ($\chi^2_{\text{Difference}} = 2.00, ns$). Thus, the quadratic model was used as the base model for analyses.

Primary analyses—To investigate whether there were subgroups of individual with distinct PTSD and SUD trajectories, we compared one-through six-class solutions using LCGAs. As noted, the quadratic model was used as the base model. It should be noted that, consistent with prior literature, variances for latent variables were fixed to be equal across groups (Jackson & Sher, 2008). As shown in Table 1, selection of the best-fitting model was not straightforward. The four-, five-, and six-class models all demonstrated satisfactory fit and similar fit statistics. Specifically, the AIC and SABIC provide evidence that the six-class model is the best-fitting solution. The BIC and LMR LRT suggest that a four-class model provides the best solution.

To examine the substantive meaning of each solution, we examined graphic representations of each solution. The four-class solution was characterized by the four descriptions we hypothesized: low SUD–low PTSD (62.8% of the sample), low SUD–high PTSD (15.7% of the sample), high SUD–high PTSD (4.0% of the sample), and high SUD–low PTSD (17.5%). Thus, participants at relatively high risk for both disorders across time were less common. The five-class solution retained four of the same classes: low SUD–low PTSD (57.9%), low SUD–high PTSD (15.7%), high SUD–high PTSD (4.0%), and high SUD–low PTSD (9.4%) and added a group characterized as moderate SUD–low PTSD (13.1%). The six-class solution was characterized by the four classes identified earlier: low SUD–low

PTSD (62.4%), low SUD– high PTSD (7.7%), high SUD– high PTSD (3.8%), and high SUD–low PTSD (17.5%). Two new classes that appeared in this model were both characterized by low SUD and by sharp changes in the PTSD probability across time. One very small group had an increasing trajectory of PTSD probability (low SUD–increasing PTSD, 1.8%). The second group had a decreasing probability of PTSD over time (low SUD–decreasing PTSD, 6.8%). Given the disparate information the fit indices provided and the increased emphasis placed on considering the substantive meaning of structural equation modeling solutions (e.g., Tomarken & Waller, 2003), the six-class model was considered the best-fitting solution and was used in follow-up analyses. The six-class model is depicted in Figure 1. Entropy for the six-class solution, which is an index of how well individuals were classified into subgroups, was excellent (0.93).

Follow-up analyses—Demographic data for each of the six classes are provided in Table 2. This table also includes data about trauma exposure, including the age at which participants experienced their first traumatic event. Using chi-square analyses, we investigated the distribution of class assignment by cell membership, using the five cells employed by the CLPS project: schizoid, borderline, avoidant, obsessive–compulsive, and depression. The distribution of cell assignments deviated from the overall base rate in the sample (Pearson $\chi^2 = 75.486$, $p < .01$). Table 3 provides specific details about the distribution of cell membership within each class. Within the low SUD–low PTSD group, the majority of participants were assigned to either the avoidant ($n = 106$, 25.3%) or obsessive–compulsive ($n = 117$, 27.9%) cells. Within the high SUD–high PTSD group, a majority of participants ($n = 17$, 65.4%) were assigned to the borderline cell. We also conducted a series of pairwise comparisons, using the low SUD–low PTSD group as the reference group, and found that four of the other groups (low SUD–decreasing PTSD, low SUD–high PTSD, high SUD–high PTSD, and high SUD–low PTSD) demonstrated a statistically significant different distribution among the study cells ($ps < .01$).

Relations Between Class Membership and Functioning

To further characterize the groups, we conducted a multivariate analysis of variance (MANOVA) on a set of variables assessing psychosocial functioning, including GAF score, global satisfaction; occupational functioning; recreation; social adjustment; and interpersonal relationships with spouse or mate, parents, siblings, and friends, assessed by the LIFE. The MANOVA was significant, Wilks's $\Lambda = .612$, $F(45, 714.348) = 1.841$, $p < .001$. Univariate results were significant for five of the functioning variables, including GAF score, occupational functioning, social adjustment, and interpersonal relationships with siblings and friends. We followed this analysis with a series of univariate contrast analyses to identify specific between-groups differences on each variable, the results of which are displayed in Table 4. An overall pattern emerged such that Group 4 (low SUD–low PTSD) evidenced better functioning than most of the other groups on most domains. Specifically, for GAF, the low SUD–low PTSD group demonstrated a significantly higher score than all other groups, except for the low SUD–increasing PTSD group.

Relations Between Class Membership and Personality Variables

We conducted a series of MANOVAs to investigate differences among the classes on the triad of personality trait variables of PT, NT, and DIS at each time point. Table 5 presents the means and standard deviations for all groups. A graphical depiction of the personality trajectories by class is included in Figure 2. The baseline MANOVA results suggested a significant overall multivariate effect for class, Wilks's $\Lambda = .841$, $F(15, 1814.09) = 7.839$, $p < .001$, and univariate results found significant differences on NT, $F(5, 393) = 7.024$, $p < .001$, and DIS, $F(5, 393) = 16.401$, $p < .001$.

At 1 year, there was a significant overall multivariate effect for class, Wilks's $\Lambda = .773$, $F(15, 1079.78) = 7.030$, $p < .001$, and follow-up univariate tests indicated significant differences on all three dimensions: PT, $F(5, 393) = 2.703$, $p < .001$; NT, $F(5, 393) = 5.519$, $p < .001$; and DIS, $F(5, 393) = 14.463$, $p < .001$. At 2 years, the multivariate results were again significant, Wilks's $\Lambda = .799$, $F(15, 1253.695) = 7.089$, $p < .001$, and univariate results indicated significant differences on NT, $F(5, 456) = 5.266$, $p < .001$, and DIS, $F(5, 456) = 15.998$, $p < .001$. At 3 years, results again suggested a significant overall multivariate effect for class, Wilks's $\Lambda = .784$, $F(15, 1181.921) = 7.254$, $p < .001$, and univariate results found significant differences on NT, $F(5, 430) = 6.009$, $p < .001$, and DIS, $F(5, 430) = 16.661$, $p < .001$. Results from contrast analyses to identify between-groups differences on the three dimensions are presented in Table 5. At the first three time points, Groups 5 and 6 were discriminated from the other groups by higher scores on DIS. Group 4 showed a trend suggesting lower scores on NT across time. PT demonstrated less differentiation between groups than did the other two dimensions. However, there was a pattern for the low SUD–high PTSD group (Group 2) and the low SUD–increasing PTSD group (Group 3) to show lower scores on that dimension across time, with both of them scoring significantly lower than Groups 1 (low SUD–decreasing PTSD) and 4 (low SUD–low PTSD) at Year 1, and Group 2 scoring significantly lower than all of the other groups, with the exception of Group 3, at Year 3. The groups that were characterized by high probabilities of SUD (5 and 6) demonstrated consistently higher scores on DIS over time. With regard to NT, all of the groups showed a trend toward lower scores over the four time points. Group 1 (low SUD–decreasing PTSD) showed the steepest slope, having among the highest scores at baseline and scoring significantly lower than Group 2 (low SUD–high PTSD) at 3 years.

Discussion

The problem of co-occurrence of PTSD and substance abuse has been the subject of increasing interest in recent years. A number of treatments have been developed specifically for the treatment of PTSD-SUD (e.g., Najavits, 2002; Triffleman, 2000), and researchers have adopted innovative techniques to further the field's understanding of how the two disorders co-occur. The current study sought to describe trajectories of PTSD-SUD co-occurrence in a heterogeneous psychiatric sample.

Examining the aggregated data, we found that among participants with PTSD, there was a higher rate of both AUDs and DUDs. This finding is consistent with a growing literature demonstrating higher rates of SUD among persons with PTSD. For example, in the National Vietnam Veterans Readjustment Survey, approximately 74% of men and 29% of women

with current PTSD had a lifetime diagnosis of alcohol abuse (Kulka et al., 1990). In clinical samples of treatment-seeking veterans with PTSD, rates of lifetime alcohol disorders range from 47% to 77% (Ruzek, Polusny, & Abueg, 1998).

We conducted LCGA to investigate subgroups of participants based on trajectories of subgroups of participants. We used the full sample from the CLPS project, many of whom did not carry diagnoses of PTSD or SUD. LCGA resulted in viable models comprising four to six classes. Because of the exploratory nature of this investigation, we selected the solution that generated the largest number of classes but still demonstrated good fit to the data and arrived at a six-class solution. In this solution, the majority of participants were those with neither PTSD nor SUD diagnoses. The five remaining classes could broadly be described as low SUD–high PTSD, high SUD–high PTSD, high SUD–low PTSD, low SUD–increasing PTSD, and low SUD–decreasing PTSD. It is interesting in this sample that a relatively small proportion (about 4%) of participants were characterized as having a high probability of both disorders across time. A substantially larger proportion (about 25%) demonstrated a high probability of one or the other disorder at each time point. Another striking finding was the consistency across time; for a majority of classes, the trajectories for each disorder are relatively flat. The two exceptions to this trend were the trajectories for PTSD in two of the classes (Class 1, low SUD–decreasing PTSD, and Class 3, low SUD–increasing PTSD). For both of these classes, changes in PTSD occurred apparently independently of any change in SUD probability.

The classes were compared on a range of variables, including demographic characteristics, CLPS study cell assignment, psychosocial functioning, and broad trait dimensions. On most variables, there was a trend toward more pathological scores for the high SUD–high PTSD group and less pathological scores for the low SUD–low PTSD group, with significant differences emerging between these extreme groups. The distribution of CLPS cell assignments was similar, with the low SUD–low PTSD class having less than 20% of participants with borderline personality disorder and the high SUD–high PTSD group having more than half borderline participants. Notably, the groups characterized by higher probabilities of PTSD reported substantially younger ages of first trauma.

The groups were also compared on a set of broad personality dimensions including PT, NT, and DIS. These traits have been demonstrated to be important components of a dimensional approach to psychopathology (Krueger, McGue, & Iacono, 2001). Investigations of the patterns of these broad traits in samples with high base rates of PTSD have suggested that a subtype of PTSD characterized by high scores on the DIS (or disinhibition) and NT (or negative emotionality or neuroticism) dimensions demonstrates high rates of comorbid substance abuse (Miller, Grief, & Smith, 2003; Miller, Kaloupek, Dillon, & Keane, 2004). Furthermore, an investigation of the role of DIS and NT in the relationship between PTSD and SUD found that these trait dimensions appear to fully mediate the relationship (Miller, Vogt, Mozley, Kaloupek, & Keane, 2006). In the present sample, the low SUD–low PTSD group evidenced lower scores on DIS compared with groups that demonstrated high probabilities of SUD. Although few significant differences emerged for the PT dimension, visual inspection of the graphs suggests that the low SUD groups that demonstrated either a consistently high probability of PTSD (Class 2) or increasing probability of PTSD (Class 3)

experienced a different trajectory for PT than the other groups, suggested by a steep decrease after baseline, in contrast to the increasing slope displayed by the other four groups. This pattern suggests that the variant of PTSD that is not associated with comorbid substance abuse may be characterized by lower positive affect, relative to those with cooccurring substance abuse.

With regard to NT, several of the groups displayed decreasing scores over time, although the high SUD–high PTSD group displayed a variable pattern across time and the low SUD–high PTSD group displayed consistently high scores. DIS scores were remarkably consistent over time, and the DIS dimension also seemed critical to discriminating between groups with and without SUD, consistent with prior literature (Sher & Trull, 1994). These findings suggest that all three broad trait dimensions may be important to differentiating among combinations of PTSD-SUD pathology.

In sum, our findings suggest that persons with a high probability of co-occurring PTSD and SUD are a minority of patients, but that they demonstrate a relatively chronic course of both disorders and that they demonstrate worse functioning overall, particularly compared with patients with a low probability of either PTSD or SUD. Our data do not suggest that patients cycle in and out of episodes of PTSD and SUD. Over the five time points, most subgroups demonstrated little change in the probability of either disorder across time. Two classes demonstrated significant change in PTSD probability over time in the absence of any change in SUD probability, findings that apparently contradict the notion that functional relationships exist between the two disorders.

Strengths of this study include a relatively large sample with a diverse array of psychopathology and personality traits. Participants were carefully assessed using structured clinical interviews. The availability of longitudinal data spanning 5 years is also a strength. The LCGA techniques allowed us to examine heterogeneity with respect to PTSD-SUD relations over time, a novel contribution to the literature.

Some important factors limit conclusions that may be drawn from this work. First, our sample, although recruited from clinical settings and diverse in terms of demographics and clinical characteristics, is not representative of samples found in clinical settings because of the inclusion and exclusion criteria employed. The CLPS focuses specifically on four personality disorders and on major depressive disorder in the absence of any personality disorder. There-fore, this sample does not reflect base rates found in typical clinical settings. Second, we did not use continuous measure of PTSD, which limited our ability to investigate PTSD severity or the role of specific symptom clusters and how they relate to personality variables. Third, we used categorical diagnostic variables corresponding to presence or absence of PTSD and SUD diagnoses at each time point. A growing body of literature suggests that psychopathology may be best represented by dimensions rather than categories (Broman-Fulks et al., 2006; Martin, Chung, & Langenbucher, 2008).

The results presented here suggest that the joint trajectories of PTSD-SUD may vary within samples and that aggregated data may conceal important heterogeneity. In the current sample, this heterogeneity appeared best represented by six distinct classes. The classes

differed with regard to functioning and personality variables. Future investigations are needed to further explore the clinical implications of these subtypes.

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Figure 1.
Six-class latent class growth analysis solution.

Figure 2.
Graphs of personality trajectories for three broad dimensions, by class.

Table 1

Fit Indices and Entropies for Latent Class Growth Mixture Models

Number of classes	AIC	BIC	SABIC	LMR LRT	Entropy
1	5577.00	5604.03	5584.97	—	1.00
2	4440.17	4498.72	4457.45	1126.10 ^a	0.96
3	3770.09	3860.17	3796.70	669.38 ^a	0.92
4	3622.92	<u>3744.53</u>	3658.80	<u>157.71</u> ^a	0.93
5	3595.36	3748.49	3640.54	72.50	0.88
6	<u>3572.47</u>	3757.15	<u>3626.77</u>	38.18	0.93

Note. $N = 668$. AIC = Akaike information criterion; BIC = Bayesian information criterion; SABIC = sample-size adjusted Bayesian information criterion; LMR LRT = Lo–Mendell–Rubin likelihood ratio test. The null hypothesis for p values associated with the LMR LRT is that a solution with a given number of classes provides the same fit to the data as a solution with one fewer class. Underline indicates the best-fitting model according to a particular index of fit.

^a According to LMR LRT, model fits significantly better than solution with one fewer class.

Table 2

Demographics for Six-Class Solution

Variable	Class					
	1	2	3	4	5	6
<i>M</i> (<i>SD</i>) age (years)	33.51 (8.90)	34.14 (7.16)	33.91 (8.43)	32.47 (8.08)	33.73 (7.31)	32.38 (8.46)
Gender (% male) *	23.1	21.4	9.1	35.8	34.6	54.7
Race (%)						
Caucasian	74.4	67.9	90.9	76.4	76.9	76.1
African American	10.3	23.2	0.0	9.5	23.1	14.5
Hispanic	15.4	16.3	0.0	10.7	0.0	6.8
Marital status (% married or cohabiting) **	35.9	23.3	18.2	26.7	19.2	18.8
Employment (% full-time employed)	20.5	10.7	18.2	30.1	11.5	19.7
Education (% completing at least some college) ***	61.5	64.3	63.6	79.9	42.3	71.0
Trauma exposure (% endorsing at least one traumatic event)	100.0	100.0	100.0	80.8	100	91.2
<i>M</i> (<i>SD</i>) age first trauma	8.91 (6.96) _a	8.26 (5.94) _a	8.73 (4.56) _a	14.47 (8.36) _b	10.68 (6.17) _{a,c}	12.94 (7.43) _{b,c}

Note. Classes: 1 = low substance use disorder (SUD)–decreasing posttraumatic stress disorder (PTSD; $n = 39$); 2 = low SUD–high PTSD ($n = 56$); 3 = low SUD–increasing PTSD ($n = 11$); 4 = low SUD–low PTSD ($n = 419$); 5 = high SUD–high PTSD ($n = 26$); 6 = high SUD–low PTSD ($n = 117$). Subscripts a, b, and c reflect homogeneous subgroups.

* Pearson $\chi^2 = 28.87, p < .001$.

** Pearson $\chi^2 = 45.77, p < .01$.

*** Pearson $\chi^2 = 66.64, p < .001$.

Table 3

Distribution of Collaborative Longitudinal Personality Disorders Study Cells, by Class

Class	Personality disorder, <i>n</i> (%)				
	Schizotypal (<i>n</i> = 86)	Borderline (<i>n</i> = 165)	Avoidant (<i>n</i> = 166)	Obsessive–compulsive (<i>n</i> = 154)	Depression (<i>n</i> = 95)
1	6 (15.4)	16 (41.0)	10 (25.6)	6 (15.4)	1 (2.6)
2	9 (16.1)	23 (41.1)	13 (23.2)	10 (17.9)	1 (1.8)
3	0	4 (36.4)	5 (45.5)	1 (9.1)	1 (9.1)
4	50 (11.9)	75 (17.9)	106 (25.3)	117 (27.9)	71 (16.9)
5	5 (19.2)	17 (65.4)	2 (7.7)	0 (0.0)	2 (7.7)
6	16 (13.7)	40 (34.2)	22 (18.8)	20 (17.1)	19 (16.2)

Note. Classes: 1 = low substance use disorder (SUD)–decreasing posttraumatic stress disorder (PTSD; *n* = 39); 2 = low SUD–high PTSD (*n* = 56); 3 = low SUD–increasing PTSD (*n* = 11); 4 = low SUD–low PTSD (*n* = 419); 5 = high SUD–high PTSD (*n* = 26); 6 = high SUD–low PTSD (*n* = 117).

Table 4

Baseline Psychosocial Functioning (Past Month), by Class

Measure	Class					
	1	2	3	4	5	6
Global assessment of functioning	54.41 _a	54.95 _a	55.18 _{a,b}	60.44 _b	49.88 _a	54.52 _a
LIFE domains						
Social adjustment	3.85 _{a,c,d}	3.93 _c	3.45 _{a,c,d}	3.47 _d	4.12 _{b,c}	3.79 _{a,c}
Occupational functioning	3.37 _{a,b,c}	3.55 _{a,c}	2.67 _{a,b}	2.87 _b	4.26 _c	3.20 _{a,b}
Interpersonal relationships: siblings	4.74 _a	3.87 _{a,d}	4.64 _{a,d,e}	3.34 _{b,e}	4.96 _{c,d}	3.64 _{a,b,e}
Interpersonal relationships: friends	3.31 _{a,c}	3.23 _{a,c}	3.64 _{a,b,c}	2.80 _{b,c}	3.62 _a	2.99 _{a,b,c}

Note. Class: 1 = low substance use disorder (SUD)–decreasing posttraumatic stress disorder (PTSD; $n = 39$); 2 = low SUD–high PTSD ($n = 56$); 3 = low SUD–increasing PTSD ($n = 11$); 4 = low SUD–low PTSD ($n = 419$); 5 = high SUD–high PTSD ($n = 26$); 6 = high SUD–low PTSD ($n = 117$). LIFE = Longitudinal Interval Follow-up Evaluation. For all LIFE domains, severity is rated on a 5-point scale ranging from 1 (*no impairment*) to 5 (*severe impairment*). Subscripts a, b, c, d, and e reflect homogeneous subgroups, $p < .05$.

Table 5**Differences Between Groups on Personality Variables**

Variable	Class					
	1	2	3	4	5	6*
Positive temperament: baseline	12.77 _a	13.61 _a	11.73 _a	13.42 _a	11.08 _a	13.29 _a
Negative temperament: baseline	22.64 _a	22.52 _a	22.45 _{a,c}	18.80 _b	21.42 _{a,c}	20.59 _c
Disinhibition: baseline	9.36 _a	10.95 _a	8.00 _a	10.65 _a	14.38 _b	15.29 _b
Positive temperament: 1 year	14.07 _a	10.55 _b	9.67 _b	14.30 _a	13.54 _{a,b}	12.71 _{a,b}
Negative temperament: 1 year	21.81 _a	21.72 _a	21.56 _a	16.89 _{b,c}	17.31 _{a,c}	19.56 _a
Disinhibition: 1 year	9.26 _{a,b}	10.14 _{a,b}	7.00 _a	10.00 _b	15.85 _c	15.13 _c
Positive temperament: 2 year	14.41 _a	11.95 _a	11.00 _a	13.89 _a	14.00 _a	13.82 _a
Negative temperament: 2 year	19.53 _{a,c}	21.35 _c	18.11 _{b,c,d}	16.73 _b	21.15 _{a,c}	19.06 _{a,d}
Disinhibition: 2 year	9.50 _a	9.14 _{a,d}	6.89 _{b,d}	9.95 _a	14.10 _c	15.10 _c
Positive temperament: 3 year	14.67 _a	10.88 _b	11.29 _{a,b}	14.38 _a	15.33 _a	14.06 _a
Negative temperament: 3 year	15.87 _{a,c}	20.85 _b	19.29 _{b,c}	15.02 _c	18.94 _{a,b}	18.71 _{a,b}
Disinhibition: 3 year	7.57 _a	9.85 _{a,c}	8.43 _{a,c}	9.21 _a	12.94 _{b,c}	14.76 _b

Note. Class: 1 = low substance use disorder (SUD)—decreasing posttraumatic stress disorder (PTSD; $n = 39$); 2 = low SUD—high PTSD ($n = 56$); 3 = low SUD—increasing PTSD ($n = 11$); 4 = low SUD—low PTSD ($n = 419$); 5 = high SUD—high PTSD ($n = 26$); 6 = high SUD—low PTSD ($n = 117$). Subscripts a, b, c, and d reflect homogeneous subgroups, $p < .05$.