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The Class-Dimensional Structure of PTSD Before and After Deployment to Iraq: Evidence from
Direct Comparison of Dimensional, Categorical, and Hybrid Models

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This research was supported by grants from Minnesota Medical Foundation (3662-9227-06) and Department of Defense Congressionally Directed Medical Research Program (CDMRP; W81XWH-07-2-003). This material is the result of work supported with resources and the use of facilities at the Minneapolis VA Health Care System, Minneapolis, MN.

Abstract

The assumption of specific etiology in posttraumatic stress disorder (PTSD) differentiates the disorder from most other psychiatric conditions. A ‘risky test’ of the assumption of specific etiology and resultant trauma-related symptom dimensions was conducted through structural modeling of PTSD symptoms in soldiers before ($N = 522$) and after ($n = 423$) a combat deployment to Iraq. If PTSD represents a discrete diagnostic entity that emerges after trauma exposure, we hypothesized either the number of latent classes should increase from pre- to post-deployment or symptom dimensions should qualitatively distinguish affected from unaffected classes following trauma exposure. Comparison of latent structural models revealed best fitting hybrid models for PTSD and depression with strong invariance of symptom dimensions across classes both before and after deployment and only quantitative (i.e., severity) differences between classes. These findings suggest PTSD is generally well-conceptualized as a dimensional syndrome worsened but not necessarily elicited by trauma exposure.

Key Words: PTSD, depression, dimensions, classes, structure

1.1 The Assumption of Specific Etiology

PTSD claims a unique status among disorders defined in the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM-IV*; American Psychiatric Association, 1994; 5th ed.; *DSM-5*; American Psychiatric Association, 2013) in that the criteria for diagnosis include a specified etiology. *DSM-IV* Criterion A requires exposure to a traumatic event that both involved the threat of death, serious injury, or a threat to the physical integrity of self or others and a response to the event that included fear, helplessness, or horror. In *DSM-5*, although the requirement of a specified emotional response to the event is dropped, exposure to a circumscribed class of events remains. Moreover, the concomitant re-experiencing, avoidance/numbing, and hyper-arousal symptoms must both post-date and be directly tied to the traumatic event. Thus, unlike other DSM diagnoses, PTSD both assumes and requires a specific etiology (a specific traumatic event), implying that a distinctive class of events is causally related to a unique class of symptoms. Empirically, identification and inclusion of a necessary etiological criterion for a mental disorder such as PTSD, requires a clearly defined pathogenic pathway between the causative factor and the onset and maintenance of the disorder.

Although exposure to a traumatic event is widely accepted to be a specific etiological factor in the development of PTSD, endorsement of PTSD symptoms occurs in the absence of exposure to traumatic events (Bodkin, Pope, Detke, & Hudson, 2007; Erwin, Heimberg, Marx, & Franklin, 2006; Gold, Marx, Soler-Baillo, & Sloan, 2005; Simons & Silveira, 1994; Solomon & Canino, 1990). Given plethora findings suggesting PTSD symptoms are common among non-traumatized populations, the assumption that the disorder is a discrete condition arising following a traumatic event requires further testing. If PTSD is indeed a distinct disorder that emerges after traumatic events, one would expect to find a) a distinct class of individuals

endorsing the symptoms and b) that this class emerges following exposure to traumatic events. While it is impossible to test for such a hypothesis in a classical experiment, if we are able to evaluate PTSD symptoms before and after expected trauma exposure we can test this hypothesis in a naturalistic experiment.

1.2 The Assumption of Structure

The construct validity of PTSD as a diagnostic entity rests on the assumptions of specific etiology and a causal relationship between the etiological trauma and the multi-factorial symptom presentation. These assumptions, in turn, have implications for the expected underlying structure of PTSD symptoms. The illness is the conjunction of its etiology and pathology. As such, the assumption of specific etiology would appear to *qualitatively* distinguish between individuals exposed to a qualifying traumatic event from those who have not been exposed to a qualifying traumatic event (i.e., experienced Criterion A vs did not). The assumption of a multi-faceted structure of the symptoms of PTSD would appear to *quantitatively* distinguish pathological from non-pathological responses to traumatic events (i.e., allowing for differential expression of the syndrome across facets). If the assumption of specific etiology presupposes that PTSD represents a difference *in kind* from normative stress reactions to adverse events, and the multi-faceted structure presupposes that PTSD represents a difference *in degree* distinguishing these pathological responses from normative ones, do these assumptions conflict? Would the syndrome best be conceptualized as dimensional, categorical, or some combination thereof? To address this question, investigations of the structure of PTSD have been conducted using each of these conceptualizations.

1.2.1 Dimensional Conceptualizations of PTSD

Assuming a dimensional structure, latent trait modeling (LTM) of the 17 DSM-IV PTSD has been conducted using factor analysis. Comparison of models across various measures of PTSD has generally converged on a four or five-factor structure. The ‘numbing’ model (King, Leskin, King, & Weathers, 1998) is consistent with DSM-IV PTSD criteria but for separation of criterion C into avoidance and emotional numbing factors, and the ‘dysphoria’ model (Simms, Watson, & Doebbeling, 2002) includes a dysphoria factor comprising the first five Criterion C symptoms and the first three Criterion D symptoms, along with a two-item avoidance factor. The four-factor ‘dysphoria’ model (Simms et al., 2002) has received additional support through evidence of measurement invariance (Elhai et al., 2009; Meis, Erbes, Kaler, Arbisi, & Polusny, 2011), literature review (Elhai & Palmieri, 2011), meta-analysis (Yufik & Simms, 2010), and external validation (Gootzeit & Markon, 2011). The five-factor ‘dysphoric arousal’ model, parsing dysphoria symptoms into an additional factor, has received empirical support as well (Elhai et al., 2011).

1.2.2 Categorical Conceptualizations of PTSD

Assuming a categorical latent structure, latent class modeling (LCM) has been conducted in a variety of samples where varying proportions of members were exposed to trauma. In two large, community-based samples of individuals exposed to trauma, Breslau, Reboussin, Anthony, and Storr (2005) found evidence of three latent classes associated with no disturbance, intermediate disturbance, and pervasive disturbance. In both samples, the emotional numbing cluster of symptoms was shown to differentiate no disturbance and intermediate disturbance from pervasive disturbance classes. In the National Vietnam Readjustment Study, latent class analysis was conducted on a sample of individuals evidencing current PTSD symptomatology as defined by the DSM-III-R (American Psychiatric Association, 1987) criteria (Steenkamp et al.,

2012). No disturbance, intermediate disturbance, and pervasive disturbance classes emerged, with avoidance and hypervigilance symptoms differentiating the pervasive from classes of lesser severity. Latent class analyses were conducted on PTSD symptoms in the National Survey of Adolescents – Replication study at two time points following exposure on those reporting prior trauma at Wave 1 (Ayer et al., 2011). Again, three latent classes at both Waves 1 and 2 were identified, no disturbance, intermediate disturbance, and pervasive disturbance classes. The pervasive disturbance class was best distinguished from the intermediate disturbance class by emotional numbing and hyperarousal symptoms at Wave 1, and by re-experiencing, avoidance, and hyperarousal symptoms at Wave 2. To date, then, latent class analyses have suggested some possible differences *in kind* for PTSD symptoms. However, latent class analyses in these trauma-exposed samples were consistent in identifying three classes differentiated by severity, which may not be inconsistent with dimensional conceptualizations as continuous differences in severity can only be described in terms of alternative classes using LCM. Indeed, when modeling PTSD with comorbid depression and generalized anxiety disorder, three classes also emerge based on severity levels rather than symptom type (Armour et al., 2015; Contractor et al., 2015).

1.2.3 Dimensional, Categorical, or Mixture Conceptualizations of PTSD

Two types of analytical approaches have been implemented to compare dimensional, categorical representations, and/or a mixture of the two: taxometric analyses and factor mixture models. Taxometric analytic tools were developed specifically to evaluate evidence for the hypothesis that a taxon (a discrete latent group) may be identified by a specific set of indicator variables (e.g., Meehl, 1995; Waller & Meehl, 1998). Taxometric analysis is conceptually similar to two-class latent class analysis, though the statistical methods developed under this

rubric are distinctive from those employed in latent class analysis. A taxon is not synonymous with a latent class, as Meehl (1992) states ‘All taxa are classes, but not all classes are taxa... Perhaps the commonest way of explicating the taxon concept is to say that a genuine taxon is a natural kind, as opposed to an arbitrary class.’ Ruscio, Ruscio, and Keane (2002) performed three taxometric procedures using interview and self-report data in a sample of male, treatment-seeking combat veterans. Each procedure yielded results suggesting that posttraumatic stress responses are dimensional in nature. These results were replicated using interview and self-report data in a male, community-based sample of male combat veterans with a lower estimated prevalence of PTSD (Forbes, Haslam, Williams, & Creamer, 2005). The results of these analyses suggest that PTSD symptomatology is dimension-like, that no taxa or ‘natural kind’ emerges when dimensional and categorical representations of the syndrome are directly compared.

To our knowledge, few studies to date have used factor mixture modeling in evaluating the structure of PTSD. Factor mixture modeling provides for simultaneous inclusion of both latent classes and multiple latent dimensions within the same structural domain (Lubke & Muthén, 2005). The focus of extant studies, however, has been largely to compare the two predominant LTMs of DSM-IV PTSD symptomatology, namely the four-factor ‘numbing’ (King et al., 1998) and ‘dysphoria’ (Simms et al., 2002) models. In a Canadian sample of veterans referred for psychiatric evaluation, Naifeh, Richardson, Del Ben, and Elhai (2010), used a factor mixture modeling approach specified to identify one- or two-class variants of four-factor models parameterized as the ‘dysphoria’ and ‘numbing’ models. Two-class, four-factor solutions fit better than one-class, four-factor solutions in both cases. The differences in factor means between class one and class two were interpreted as differences in severity. Shevlin and Elklit

(2012) used confirmatory factor mixture modeling to compare the fit of the ‘numbing’ and ‘dysphoria’ models in a combined sample of subpopulations exposed to different types of trauma. A two-class model in which the factor structures of the ‘numbing’ and ‘dysphoria’ models were parameterized to distinguish classes were compared with one- and two-class ‘dysphoria’ and ‘numbing’ factor mixture models that varied across class in item thresholds (i.e., item endorsement differences across class). The best-fitting model was the former, with class membership and therefore the preference for the dysphoria or numbing model of PTSD associated with trauma type. Unfortunately, the question of whether the classes reflected differences in kind versus degree/severity was not adequately addressed in either study as the focus was on comparison of the two models. The first study found differences in severity in the two classes, and the latter did not report models with alternative measurement invariance constraints.

Taken together, the majority of the work on the latent structure of PTSD has utilized one analytical approach, usually a dimensional one. In so doing, the resulting underlying structure of the syndrome is preordained: the structure is dimensional (four factors), categorical (three classes), or a class-dimensional hybrid (two classes, four factors). The analytic approach has dictated the structure, and in the latter approaches the classes are largely differentiated by severity. Taxometric findings are limited in being specifically designed to test the taxonic conjecture, i.e., the evidence for a latent structure consisting of a taxon group and its complement group, and are not designed to parameterize other alternatives (e.g., a potential multi-dimensional structure of the symptoms, or more than two latent groups). If PTSD symptoms represent a number of dimensions that vary continuously in the population, perhaps regardless of trauma exposure (e.g., Gold et al., 2005), then we have defined the syndrome based on arbitrary cut

points of severity on dimensions that may or may not be necessitated by trauma. To our knowledge, there have been few ‘risky tests’ of the assumption that the symptom dimensions of PTSD categorically differentiate pathological from normative responses to Criterion A events rather than differentiating the degree of response to stressful events.

1.3 The Current Study: Direct Comparison of Latent Trait, Latent Class, and Factor Mixture Models

Trauma exposure cannot be manipulated in the laboratory to experimentally test the etiological hypothesis or to document the sequelae of various forms of trauma. The rationally derived criteria appear to reflect stress reaction dimensions that the majority of the literature suggests *quantitatively* distinguish debilitating from lesser degrees of distress. Evidence supporting *qualitative* distinctions in endorsement of PTSD criteria between affected versus unaffected and exposed versus unexposed individuals is limited. The current study is one of few that assessed individuals prior to exposure to potentially traumatic combat-related events (Polusny et al., 2011). Using a quasi-experimental design, we tested the hypothesis that PTSD criteria will qualitatively distinguish between pathological and normative stress responses following trauma exposure through comparison of latent trait models, latent class models, and factor mixture models. PTSD symptomatology was assessed in a sample of National Guard Soldiers both before and after deployment to Iraq. Evidence for qualitative differences in the latent structure of PTSD could arise following deployment in a number of ways: 1) a latent PTSD class not present prior to combat exposure should emerge following combat exposure, 2) the symptom facets should qualitatively distinguish affected from unaffected classes following combat-related trauma exposure, or 3) the symptoms may be expected to differ in the manner in which they coalesce (i.e., in the number and/or nature of the factors) before and after trauma

exposure. In addition, we examined the specificity of PTSD structural differences before and after trauma by comparing latent trait models, latent class models, and factor mixture models in depression, a disorder that does not assume the specific etiology of trauma exposure or a multi-dimensional structure causally-linked to trauma. Lacking a qualitative etiological delineation between those with and without depression, structural differences before and after trauma exposure may be expected to be quantitative.

Material and Methods

2.1 Participants

The sample was recruited from a US National Guard Brigade Combat Team (BCT) deployed to Iraq during Operation Iraqi Freedom (OIF) from March 2006 through July 2007. During mobilization training, participants ($N = 522$) were asked to complete a self-report survey comprising a battery of risk and resilience measures. Administration of the surveys was standardized in a group classroom setting approximately one month prior to deployment. Two to three months after the soldiers returned from deployment, surveys were mailed to participants with a monetary incentive. Response rates were maximized through repeated mailing procedures ($n = 423$; 81.2% of the pre-deployment sample). The assessment battery and description of differences between post-deployment responders and non-responders on pre-deployment variables are described in Polusny et al. (2011), which additionally lists the prevalence of combat-related stressors reported by the soldiers (see Table 2). The sample was predominantly male ($n = 462$, 88.5%) and Caucasian ($n = 490$, 93.9%) with 14.2 (2.00) years of education. Income was not directly assessed. Study procedures were approved by the human subject research review boards of the Minneapolis VA, University of Minnesota, Army, and Army National Guard commands.

2.2 Measures

2.2.1 Posttraumatic Stress Disorder Checklist (PCL)

The PTSD Checklist (PCL; Weathers et al., 1993) is a 17-item instrument designed to assess symptoms of PTSD defined in the DSM-IV-TR. Two versions of the PCL were administered to participants, the PCL-C (Civilian) and the PCL-M (Military) during pre- and post-deployment waves of data collection, respectively. The PCL-C references symptoms to the problems and complaints individuals sometimes have in response to ‘stressful experiences’ and the PCL-M references symptoms in response to ‘stressful military experiences.’ PCL items were scored on a five-point scale according to how distressing specific problems had been during the prior month (i.e., *Not at all*, *A little bit*, *Moderately*, *Quite a bit*, *Extremely*). Average pre- and post-deployment scores on the PCL-C was 26.2 (10.01) and 35.7 (13.96) for the PCL-M, and Cronbach’s α were .92 and .94, respectively.

2.2.2 Beck Depression Inventory-II (BDI-II)

The Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996) is a 21-item instrument developed to assess the criteria of depression as defined in the DSM-IV. Each item lists four statements of increasing severity for the assessment of both the presence and intensity of depression symptoms, scored from zero to three. Psychometric properties of the BDI-II are well established (e.g., Arnau, Meagher, Norris, & Bramson, 2001; Beck et al., 1996; Segal, Coolidge, Cahill, & O’Riley, 2008). Average pre- and post-deployment scores on the BDI-II were 6.0 (6.82) and 9.7 (8.19), and Cronbach’s α were .91 and .92, respectively.

2.3 Statistical Analyses

The symptom response patterns of PTSD and depression as measured by the PCL and BDI-II, respectively, were examined using latent trait models (LTMs), latent class models

(LCMs), and hybrid LTM/LCA factor mixture models (FMMs). LTMs represent patterns of symptom endorsement in terms of unobserved trait-dimensions or continua reflecting quantitative differences in liability. LCMs represent patterns of symptom endorsement in terms of unobserved categories or classes of individuals reflecting qualitative differences in liability. Finally, hybrid LTM/LCA FMMs represent patterns of symptom endorsement in terms of both latent trait-dimensions and classes, with class composition representing either quantitative or qualitative differences in liability.

2.3.1 Latent Trait/Quantitative Models of Liability

Confirmatory factor analysis (CFA) models both the number of latent dimensions underlying covariation between measured variables and the nature of the factors, or the specific items loading on particular factors. Factors of a confirmatory model may be conceptualized as continuous latent traits accounting for individual differences in the likelihood of endorsement of items/symptoms, or underlying liability dimensions. The structural models of PTSD in the current analyses were informed by prior work with the PCL. Specifically, we compared one-, three-, and two distinct four-factor models ('numbing' model; King et al., 1998; 'dysphoria' model; Simms et al., 2002). One-factor models of depression were compared with two-factor models informed by exploratory factor analyses (EFA) and previous work on the structure of the BDI-II (e.g., Beck et al., 1996; Dozois, Dobson, & Ahnberg, 1998; Shafer, 2006).

Latent class factor analysis (LCFA) is a non-parametric latent trait modeling approach to representation of a non-normal factor distribution. Here item thresholds and factor loadings are held invariant across latent trait values or latent 'classes,' the factor variances and covariances are fixed at zero, and the only parameter differentiating classes is the factor mean. By constraining the item thresholds and factor loadings to be equal, we tested whether the disorder is

being measured in the same way across classes. By constraining the factor covariance matrix to zero, we tested whether there are differences in severity between members with the same latent trait or latent ‘class’ value. The factor distribution is non-parametric because it is freely estimated or discretized into a finite number of values that give rise to quantitative differences in amounts of disorder limited in number of amounts to that of the number of latent trait values. Class membership is based on each individual’s location on the factor, and this approach offers the most direct comparison to latent class analysis (i.e., values vs, classes).

2.3.2 Latent Class/Qualitative Models of Liability

Latent class analysis (LCA) identifies groups or classes of mutually exclusive individuals with the same patterns of item or symptom endorsement (Lazarsfeld & Henry, 1968; McCutcheon, 1987). Probable class membership of each individual is estimated based upon observed item endorsement patterns, and the items themselves are unrelated other than through their relationships to the classes (i.e., ‘conditional independence’). Conceptually, all members within each class have the same underlying likelihood or liability toward endorsement of specific items. By comparing the fit of LCFAs and LCAs with the same number of class values, we tested whether discrete categories or finite gradations of severity better comprised liability.

2.3.3 Hybrid Quantitative/Qualitative Models of Liability

Factor mixture modeling (FMM) is a hybrid approach to conventional confirmatory factor analysis and LCA. Whereas LCA identifies classes of individuals endorsing specific patterns of symptoms and CFA elucidates latent dimensions underlying relationships between symptoms, FMM identifies classes of individuals with similar response patterns while simultaneously acknowledging the symptom structure of those response patterns. Imposition of a variety of measurement invariance constraints across latent classes can reveal whether the

factors of the disorder are measured in the same way across classes (i.e., quantitative or qualitative differences across classes).

We initially tested for strong factorial invariance (Meredith, 1993) across classes of each FMM, the default for FMM in *Mplus* (Muthén & Muthén, 1998-2012). In these models, we constrained item thresholds (i.e., intercepts in the regression of observed item response options on the factors), factor loadings, and the factor covariance matrix to be equal across classes, with only the factor means varying across classes. Here, the factors comprising the disorder are being measured in the same way across classes, the relationships between factors are the same across classes, and individual differences are accounted for by differences in severity on the factors (i.e., quantitative differences between classes).

Following identification of the best fitting of these models, we tested whether relaxation of specific constraints improved model fit in accordance with the steps described by Clark and colleagues (2013). The first model variant (FMM-1) also specified the factors to be measured the same way across classes by constraining item thresholds and factor loadings to be equal across classes, but both the factor covariance matrix and factor means were allowed to vary across classes. Here, the factors are a mixture of normal distributions located at different points on the factor distribution where each normal distribution comprises a class. The next set of model constraints imposed qualitative differences in the disorder such that the factors were not measured in the same way across classes. In the second model (FMM-2), we constrained factor loadings and the factor covariance matrix to be equal across classes, fixed the factor means to zero for model identification, and allowed the item thresholds to vary across classes. Here, the classes are based on differential responses to items across classes as opposed to the factors. In the third model variant (FMM-3), we constrained factor loadings to be equal across classes, fixed

the factor means to zero, and allowed both the item thresholds and the factor covariance matrix to vary across classes. Here, the classes differ in range of severity given that factor variances were non-invariant across classes. Finally, in the fourth model (FMM-4), we allowed item thresholds, factor loadings, and the factor covariance matrix to vary across classes, with factor means fixed to zero. Here, the items evidence differential relationships with the factors across classes, and the classes differ in range of severity given that the factor variances were allowed to vary across classes.

Structural modeling analyses of the PCL and BDI-II were conducted in *Mplus* (version 7; Muthén & Muthén, 1998-2012) using maximum likelihood estimation with standard errors robust (MLR) to non-normality. The PCL and BDI-II items were specified as ordered categorical (i.e., ordinal) variables given observed non-normal distributions. MLR allowed for the comparison of relative fit of non-nested models using information-theoretic fit indices. Missing data was treated with full information maximum likelihood. The Bayesian information criterion (BIC) favors models that balance absolute fit against increases in model complexity. Differences in BIC values of 10 indicate posterior odds of 150:1, or ‘very strong’ preference for the model of lesser BIC value (Raftery, 1995). Differences in BIC have been shown to better distinguish between non-nested LTMs and LCMs in simulation studies than other information-theoretic indices computed in *Mplus* (Markon & Krueger, 2006; Nylund, Asparouhov, & Muthén, 2007). Model fit across time points was not directly assessed as these models are not directly comparable.

Results

3.1 PTSD Latent Structure

The fit of latent trait, latent class factor, latent class, and hybrid models of PTSD as measured by the PCL was compared using CFA, LCFA, LCA, and FMM, respectively. Fit statistics for PCL models are presented in Table 1.

3.1.1 Latent Trait vs. Latent Class Models of Liability

LTM of PTSD fit better than LCMs at both time points. All four trait-dimensional CFA models fit better than any LCM, including the one-factor model. Comparison of LCFA models and LCA models with the same number of values and classes, respectively, also indicated preference for dimensional, finite gradations of severity over discrete categories of individuals with the same symptom endorsement patterns. The best-fitting of the LCMs was the three-class model both before and after deployment, suggesting that no new class emerged following combat exposure. Taken together, these findings suggest that dimensional conceptualizations of PTSD symptomatology better account for liability than categorical conceptualizations both before and after combat exposure.

3.1.2 Hybrid Models of Liability

The best-fitting model overall was the two-class, four-factor ‘dysphoria’ FMM at both time points. The two classes emerging in this model differed in terms of mean levels on each of the four factors, while the factor structure, item loadings, item thresholds, factor variances, and factor covariances were held equal across classes. Prior to deployment, the proportionally smaller latent class ($n = 29$, 5.6%) evidenced greater mean levels on each of the four factors than the larger class ($n = 487$, 94.4%), though the factors were measured the same way across classes. Following deployment, all four factor means were greater in magnitude in the smaller ($n = 82$, 19.4%) than larger ($n = 341$, 80.6%) latent class, again with measurement of the factors invariant across classes. This best-fitting two-class, four-factor FMM indicated that class membership

reflected quantitative differences between classes in severity on the factors. We then tested whether the relaxation of measurement invariance constraints through allowance of quantitative or qualitative class differences improved model fit. Specifically, we compared whether specifying non-invariance across the two classes in the factor covariance matrix and factor means (FMM-1; quantitative), the item thresholds (FMM-2; qualitative), the item thresholds and the factor covariance matrix (FMM-3; qualitative), or the factor loadings, item thresholds, and the factor covariance matrix (FMM-4; qualitative) improved model fit. None of these models fit better than the two-class, four-factor FMM specifying strong measurement invariance. Model parameters for the best-fitting PCL mixture models are presented in Table 2.

3.2 Depression Latent Structure

EFA of the BDI-II at both pre-deployment and post-deployment informed specification of the two-factor models tested using CFA and FMM. The structure was consistent in terms of preferential item loadings on the Cognitive-Affective and Somatic-Vegetative factors reported by Beck et al. (1996), Dozois et al. (1998), and tested in meta-analysis (Model 3; Huang & Chen, 2015). Specifically, items 1-3, 5-9, and 13-14 were specified to load on the Cognitive-Affective factor, and the remaining items served as indicators of the Somatic-Vegetative factor. Tested also was a three-factor model of Osman et al (1997) compared in meta-analysis (Model 7; Huang & Chen, 2015). Specifically, items 1-3, 5-10, and 14 were specified to load on the Negative Attitude factor, items 4, 12-13, 15, 17, and 19-20 marked the Performance Difficulty factor, and items 11, 16, 18, and 21 loaded on the Somatic Elements factor. The fit of CFA, LCFA, LCA, and FMM models of depression are presented in Table 3.

3.2.1 Latent Trait vs. Latent Class Models of Liability

Consistent with findings for PTSD, LTMs of depression fit better than LCMs at both time points. One- through three-factor trait-dimensional CFA models fit better than any LCM. LCFA and LCA model comparisons indicated trait dimensions with limited gradations of severity were preferred over discrete liability classes. The best-fitting of the LCMs was again the three-class model both before and after deployment. Dimensional conceptualizations of depression better account for liability than categorical conceptualizations both before and after combat exposure.

3.2.2 Hybrid Models of Liability

The best-fitting model for depression was the two-class, two-factor FMM specifying strong measurement invariance at both time points. The two classes emerging in this model differed in terms of mean levels on each of the two factors, while the factor structure, item loadings, item thresholds, factor variances, and factor covariances were held equal across classes. Prior to deployment, the proportionally smaller latent class ($n = 16$, 3%) evidenced greater mean levels on both factors than the larger class ($n = 499$, 97%). Following deployment, the larger latent class ($n = 267$, 64%) evidenced greater mean levels on both factors than the smaller latent class ($n = 152$, 36%). Relaxing the strong measurement invariance constraints of the two-class, two-factor model of depression by reducing them in the manner specified in FMM-1, FMM-2, FMM-3, and FMM-4 models above revealed that no alternative model fit better at either time point. Model parameters for the best-fitting BDI-II mixture model are presented in Table 4.

Discussion

The primary objective of this study was to examine whether PTSD represents a discrete diagnostic entity through evidence of qualitative differences between normative and pathological responses to combat-related trauma. We directly compared the fit of dimensional, categorical, and class-dimensional models of PTSD before and after deployment to test the hypothesis that

the syndrome should qualitatively distinguish individuals distressed by traumatic events from those who are not. We suggested that qualitative differences could arise through emergence of a latent class following exposure that was not present prior to exposure, differences in measurement of the syndrome across affected and unaffected classes following exposure, and/or structural differences in the syndrome between time points. Our hypothesis was not supported, and similar findings in depression suggested parallels with a dimensional syndrome lacking etiological trauma-related assumptions.

4.1 The Structure of PTSD

We directly compared the fit of latent trait models, latent class models, and class-dimensional models of PTSD. No LCM fit better than any parametric LTMs, and no LCM fit better than any of their non-parametric LTM counterparts. The finding that the latent structure of PTSD is better conceptualized as dimensional rather than categorical is consistent with taxometric analyses (Forbes et al., 2005; Ruscio et al., 2002), and points to the need for comparison of LTMs in studies employing latent class analysis. The four-factor ‘dysphoria’ CFA model fit better than the four-factor ‘numbing’ model, consistent with meta-analytic work (Yufik & Simms, 2010). The three-class model was the best-fitting LCM, consistent with studies finding evidence for low, medium, and high disturbance classes (e.g., Ayer et al., 2011; Steenkamp et al., 2012). Finally, the two-class, four-factor ‘dysphoria’ mixture model fit better than the one-class, four-factor mixture model, consistent with prior research employing these methods (Naifeh et al., 2010; Shevlin & Elklit, 2012). The best-fitting model overall was the class-dimensional hybrid model specifying the structure to be consistent with the ‘dysphoria’ model of PTSD and strong measurement invariance across two latent classes. Constraining the models across latent classes to have the same factor structure, item loadings, item thresholds,

factor variances, and factor covariances, and allowing for differences in factor means indicated that the classes differed quantitatively in severity of symptom dimensions. Relaxing these constraints to allow for qualitative differences between classes did not improve model fit.

The prospective nature of the study's design allowed us to examine whether a distinctive class of individuals with PTSD would emerge following combat exposure as the assumption of specific etiology might suggest. The hypothesis that a qualitatively distinctive class would emerge following combat exposure was not supported. Assuming the inextricable linkage between the traumatic event(s) and subsequent symptom expression in the definition of PTSD, the latent structure should have looked markedly different prior to combat exposure than following combat exposure. Indeed this was not the case and a distinctive structure did not emerge in soldiers post-deployment. Further, the hypothesis that the symptom dimensions should qualitatively distinguish affected from unaffected classes following deployment was also not supported. The two-class, four-factor mixture model fit best at both time points, and only quantitative differences in severity on the four factors distinguished them at both time points. At pre-deployment, a small latent class ($n = 29$, 5.6%) evidenced higher mean levels on all four PCL factors (particularly Intrusions). At post-deployment, a somewhat larger latent class ($n = 82$, 19.4%) evidenced higher mean levels on all four PCL factors (particularly Avoidance). Prior to deployment, the two-class, four-factor PCL mixture model likely empirically identified a chronically distressed group of individuals whose symptoms were unrelated to deployment related stressors. Alternatively, PTSD symptomatology may not develop *de novo* after trauma exposure, in that this class was evident *prior to* combat exposure and the structure and measurement of the syndrome was equivalent across affected and unaffected classes both before and after combat exposure. The presence of a small group of distressed individuals prior to

deployment could be due to pre-existing PTSD symptoms stemming from previous trauma exposure (see, however, Footnote 1). It is important to note, however, that results were inconsistent with different latent structures across the distressed and non-distressed classes at either pre- or post-deployment time points. This suggests, at both time points, that distressed individuals were showing symptom differences in degree, not in kind, and argues against a distinct syndrome tied to exposure to a traumatic event.

4.2 The Structure of Depression

Given no requirement for a precipitating stressor or etiological criterion in the definition of depression, and general consensus that depression is trait-dimensional (e.g., Ruscio & Ruscio, 2000), the structure of the syndrome was not expected to be markedly different between pre-deployment and post-deployment assessments. Similar findings in the latent structures of PTSD and depression would not be expected if trauma exposure were conceptually essential and inessential in expression of symptomatology of the former and latter disorders, respectively. We found the same class-dimensional structural model fit best for depression both prior to combat exposure and following combat exposure: a hybrid two-class, two-factor, strong measurement invariance model with classes differing in severity of factor means. The factor mean differences were flipped in terms of their importance in predicting pre- and post-deployment class membership; there were greater class mean differences in the cognitive-affective factor at pre-deployment and the somatic-vegetative factor following deployment. However, as with PTSD, the structure of the syndrome was invariant across affected and unaffected classes at both time points, further calling into question the necessity of trauma exposure in the expression of either disorder.

4.3 Implications for Specific Instantiations of Distress

The heuristic value of PTSD as a disorder distinctive from extant DSM syndromes has been called into question (e.g., Rosen & Lilienfeld, 2008). There is no doubt that combat-related trauma can be distressing, as the proportion of individuals in the ‘affected’ classes increased from pre- to post-deployment. However, the findings herein imply that stress responses of affected individuals differ from those of unaffected individuals in degree, not in kind, from less debilitating reactions to potentially traumatic events. PTSD and depression have been viewed as indicators of a broader distress dimension in multivariate models of comorbidity between internalizing syndromes (Cox, Clara, & Enns, 2002; Slade & Watson, 2006). The structure of PTSD and depression may be conceptually similar because each facet of each syndrome may be a marker of a broader general distress domain. Indeed, in our sample, the BDI-II predicted post-deployment SCID-II PTSD diagnoses above and beyond an empirically-derived optimal total PCL cut score (Arbisi et al., 2012). A bottom-up approach to delineation of the structure of internalizing syndromes has been undertaken through development of the Inventory of Depression and Anxiety Symptoms (IDAS, IDAS-II; Watson et al., 2007; Watson et al., 2008; Watson et al., 2012). The structure of the IDAS yielded a general factor marked by Dysphoria accounting for approximately 90% of the variance in the domain (Watson et al., 2007). The IDAS-II Traumatic Intrusions and Traumatic Avoidance scales evidence strong convergence with PCL Intrusions ($r = .76$) and PCL Avoidance ($r = .76$) scales (Watson et al., 2012). Notably, the Traumatic Intrusions and Traumatic Avoidance IDAS scales loaded appreciably on the Distress factor of the IDAS-II, as did scales covering similar content to those of the BDI-II factors. Taken together, these findings suggest that PCL and BDI-II factors may be elements or facets of a broader internalizing domain (cf., Krueger, 1999; Wolf et al., 2014) that mark a general distress factor of this domain to varying degrees. The lack of inherent structural change

or emergence of a distinctive PTSD class following combat exposure suggests that DSM-IV symptoms as measured by the PCL may do little more to delineate individuals with a unique trauma-related syndrome than to help distinguish between individuals high and low in general distress.

The implications for discretizing PTSD without clear delineation from normative stress responses may be deleterious to both investigations of the pathogenesis of the disorder and forensic evaluation of the syndrome's consequences. If PTSD represents one instantiation of a broader distress domain in structural models of psychopathology, then by definition it shares a great deal of variance with other disorders in this domain. Latent variable modeling approaches to studying risk factor specificity have shown that general internalizing and externalizing propensities account for gender differences in prevalence of (Kramer, Krueger, & Hicks, 2008), and emergence of comorbidity between (Kessler et al., 2011), individual disorders.

Acknowledging the covariance with other distress-related syndromes through prediction of the unique variance in PTSD symptomatology after taking this shared variance into account may better delineate general versus specific risk factors for the disorder. In a similar vein, clinical differentiation of PTSD from other distress disorders is complicated both by the endorsement of symptoms by those without significant trauma exposure (i.e., pre-deployment) and by quantitative (i.e., only severity) distinctions between affected and unaffected individuals. Since binary classification of PTSD has far-reaching consequences for disability claims, clinicians would be better served by criteria that qualitatively distinguish pathological from normative responses to trauma. For example, there is evidence that dissociative symptoms (i.e., flashbacks, depersonalization, and derealization) may qualitatively distinguish between severity classes showing otherwise largely parallel PTSD symptom endorsement profiles (Wolf et al., 2012).

Further work of this kind identifying symptoms that qualitatively differentiate pathological from normative responses to stressors would facilitate demarcation of PTSD from other distress disorders, yielding greater confidence in high stakes evaluations.

4.4 Limitations

The findings of this study should be viewed in light of several limitations. First, the latent structures of the PCL and BDI-II were investigated in a National Guard sample in which only subsets of the sample evidenced clinically significant pre- and post-deployment pathology. Conversely, including in the sample individuals who did not screen positive for PTSD may also be considered a strength of the design in that it allowed for examination of measurement invariance across affected and unaffected classes. Second, the pre-deployment sample undoubtedly comprised some individuals who were previously exposed to some form of trauma (see Footnote 1). Regardless, the classes that emerged prior to deployment did not differ from the rest of the sample in terms of measurement of the syndromes. Third, the samples differed in size at pre- and post-deployment given attrition from the study. It is possible that the proportion of individuals in affected classes may have been different if all participants completed both waves of assessment. Finally, our findings contrast with a recent study finding factorial variance (i.e., differences in item thresholds) of a one-factor model of PTSD symptoms before and after deployment (Lommen, van de Schoot, & Englehard, 2014). The analytic approach did not take into account the multi-factorial structure of the symptoms, however. Despite these limitations, our findings point to the need to more carefully examine whether the sequelae of trauma articulated in the DSM PTSD criteria adequately differentiate individuals with a trauma-specific diagnostic syndrome from those exhibiting a general stress reaction unrelated to an index trauma.

Conclusions

A failure to find a change in the structure or measurement of PTSD symptoms in response to the application of a stressor suggests that PTSD is not distinct from general distress. There are two possible explanations for this failure to find the expected change in structure (rather than simply level) of PTSD symptoms following a combat deployment. First, it is possible that current self-report inventories of PTSD symptoms are so saturated in general distress that the more unique (and presumably trauma related) aspects of the disorder failed to emerge in the analyses. Given that the self-report measures are essentially restatements of DSM symptom criteria, this could have implications for the disorder itself. This leads to a second more serious implication, which is that the symptoms of PTSD may not in themselves represent unique reactions to a unique class of events (i.e., Criterion A traumatic stressors). In other words, PTSD symptoms may be symptoms of general distress that tend to go up when one is exposed to stressors, such as Criterion A events, but that can be present, to greater or lesser extent, without such stressors ever having occurred. Such an interpretation calls into question the core assumptions of the PTSD diagnosis, and analyses of the current symptoms of PTSD in a similar manner could perhaps serve to refine the syndrome in future DSM iterations.

Footnote

¹The pre-deployment sample included 29/522 Soldiers who reported a prior Operation Iraqi Freedom (OIF) or Operation Enduring Freedom (OEF) deployment. All pre-deployment PTSD Checklist (PCL) analyses of latent trait models, latent class models, and factor mixture models reported in Table 2 were re-run with exclusion of these 29 cases. The same two-class, four-factor ‘dysphoria’ model with strong measurement invariance across classes was the best-fitting model overall.

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Table 1

Fit statistics of latent trait, latent class, and hybrid models of the PCL

	<u>Pre-Deployment</u>			<u>Post-Deployment</u>		
	<u>LL</u>	<u>k</u>	<u>BIC</u>	<u>LL</u>	<u>k</u>	<u>BIC</u>
<i>Latent Trait Models</i>						
<i>CFA</i>						
1-f	-7,143	85	14,817	-7,968	85	16,449
3-f	-7,087	88	14,724	-7,837	88	16,205
4-f _N	-7,001	91	14,571	-7,762	91	16,074
4-f _D	-6,988	91	14,545	-7,709	91	15,969
5-f	-6,979	95	14,551	-7,702	95	15,979
<i>LCFA</i>						
2-value	-7,547	86	15,632	-8,445	86	17,409
3-value	-7,257	88	15,063	-8,174	88	16,881
4-value	-7,178	90	14,917	-8,042	90	16,628
5-value	-7,141	92	14,856	-8,015	92	16,587
6-value	-7,130	94	14,846	-7,978	94	16,525
<i>Latent Class Models</i>						
2-c	-7,472	137	15,800	-8,391	137	17,611
3-c	-7,160	206	15,607	-8,101	206	17,448
4-c	-7,035	275	15,788	-7,924	275	17,511
5-c	-6,927	344	16,002	-7,796	344	17,672
6-c	-6,845	413	16,269	-7,679	413	17,856
<i>Factor Mixture Models</i>						
2-c, 1-f	-7,140	87	14,823	-7,968	87	16,461
3-c, 1-f	-7,130	89	14,815	-7,965	89	16,469
4-c, 1-f	-7,129	91	14,827	-7,962	91	16,474
2-c, 3-f	-7,046	92	14,666	-7,820	92	16,197
3-c, 3-f	-7,048	96	14,695	-7,808	96	16,196
4-c, 3-f	-7,028	100	14,680	-7,806	100	16,216
2-c, 4-f _D	-6,948	96	14,497	-7,685	96	15,950
FMM-1	-7,280	90	15,123	-8,072	90	16,689
FMM-2	-6,866	160	14,732	-7,574	160	16,115
FMM-3	-6,850	170	14,763	-7,603	170	16,234
FMM-4	-6,852	191	14,896	-7,558	191	16,270
3-c, 4-f _D	-6,397	101	14,504	-7,680	101	15,971
4-c, 4-f _D	-6,936	106	14,535	-7,666	106	15,974

Note. f: factor(s). c: class(es). *LL*: log-likelihood. *k*: number of parameters. BIC: Bayesian information criterion. Subscripts: _NNumbing model, _DDysphoria model.

Table 2

PCL four-factor latent trait and two-class, four-factor mixture model standardized parameters

	Pre-Deployment			Post-Deployment		
	<i>4-f_D</i>	<i>2-c, 4-f_D</i>		<i>4-f_D</i>	<i>2-c, 4-f_D</i>	
		c1	c2		c1	c2
f1						
1. Memories	.86	.74	.74	.87	.87	.87
2. Nightmares	.86	.73	.73	.81	.80	.80
3. Flashbacks	.89	.75	.75	.83	.79	.79
4. Upset	.89	.78	.78	.85	.82	.82
5. Physio	.84	.70	.70	.83	.80	.80
f2						
6. Thoughts	.88	.80	.80	.85	.75	.75
7. Activities	.89	.82	.82	.85	.77	.77
f3						
8. Amnesia	.64	.58	.58	.69	.65	.65
9. Interest	.70	.64	.64	.83	.80	.80
10. Detached	.77	.70	.70	.88	.87	.87
11. Affect	.76	.69	.69	.88	.86	.86
12. Future	.75	.69	.69	.74	.70	.70
13. Insomnia	.72	.65	.65	.67	.64	.64
14. Irritability	.69	.61	.61	.80	.78	.78
15. Concentration	.79	.73	.73	.79	.77	.77
f4						
16. Vigilance	.79	.77	.77	.88	.84	.84
17. Startle	.90	.90	.90	.92	.95	.95
factor means						
f1 Intrusions		0.00	2.60		0.00	0.73
f2 Avoidance		0.00	1.34		0.00	2.12
f3 Dysphoria		0.00	1.54		0.00	0.86
f4 Hyperarousal		0.00	1.04		0.00	0.56

Note. f: factor(s). c: class(es). Subscript: _DDysphoria model. Factor means were fixed at zero in the first class and estimated in the second class, representing standardized differences between classes.

Table 3.

Fit statistics of latent trait, latent class, and hybrid models of the BDI-II

	<u>Pre-Deployment</u>			<u>Post-Deployment</u>		
	<u>LL</u>	<u>k</u>	<u>BIC</u>	<u>LL</u>	<u>k</u>	<u>BIC</u>
<i>Latent Trait Models</i>						
<i>CFA</i>						
1-f	-5,533	80	11,565	-5,766	83	12,035
2-f	-5,474	81	11,454	-5,693	84	11,894
3-f	-5,565	82	11,642	-5,776	85	12,065
<i>LCFA</i>						
2-value	-5,846	81	12,197	-6,162	84	12,833
3-value	-5,590	83	11,698	-5,852	86	12,224
4-value	-5,549	85	11,630	-5,789	88	12,109
5-value	-5,524	87	11,590	-5,750	90	12,045
6-value	-5,519	89	11,594	-5,742	92	12,041
<i>Latent Class Models</i>						
2-c	-5,825	119	12,394	-6,138	125	13,033
3-c	-5,531	179	12,181	-5,801	188	12,739
4-c	-5,454	239	12,401	-5,708	251	12,934
5-c	-5,397	299	12,661	-5,634	314	13,167
6-c	-5,350	359	12,941	-5,580	377	13,441
<i>Factor Mixture Models</i>						
2-c, 1-f	-5,528	82	11,568	-5,750	85	12,014
3-c, 1-f	-5,524	84	11,572	-5,739	87	12,004
4-c, 1-f	-5,523	86	11,583	-5,736	89	12,011
2-c, 2-f	-5,463	84	11,450	-5,681	87	11,888
FMM-1	-5,483	141	11,847	-5,705	147	12,298
FMM-2	-5,391	140	11,656	-5,610	143	12,084
FMM-3	-5,401	145	11,708	-5,627	148	12,149
FMM-4	-5,396	166	11,828	-5,567	169	12,156
3-c, 2-f	-5,459	87	11,461	-5,678	90	11,900
4-c, 2-f	-5,460	90	11,481	-5,674	93	11,910

Note. f: factor(s). c: class(es). LL: log-likelihood. k: number of parameters. BIC: Bayesian information criterion.

Table 4

BDI-II two-factor latent trait and two-class, two-factor mixture model standardized parameters

	Pre-Deployment			Post-Deployment		
	2- <i>f</i>	2- <i>c</i> , 2- <i>f</i>		2- <i>f</i>	2- <i>c</i> , 2- <i>f</i>	
		c1	c2		c1	c2
f1						
1. Sadness	.85	.80	.80	.81	.78	.78
2. Pessimism	.71	.66	.66	.77	.74	.74
3. Failure	.75	.72	.72	.81	.77	.77
5. Guilt	.68	.65	.65	.78	.74	.74
6. Punishment	.68	.64	.64	.76	.73	.73
7. Self-Dislike	.85	.82	.82	.86	.83	.83
8. Self-Critical	.78	.74	.74	.88	.85	.85
9. Suicidal	.82	.78	.78	.76	.71	.71
13. Indecisive	.83	.79	.79	.76	.73	.73
14. Worthless	.85	.83	.83	.92	.90	.90
f2						
4. Pleasure	.78	.75	.75	.88	.82	.82
10. Crying	.68	.64	.64	.61	.49	.49
11. Agitation	.77	.76	.76	.76	.64	.64
12. Interest	.84	.82	.82	.90	.84	.84
15. Energy	.84	.83	.83	.84	.74	.74
16. Sleep	.69	.67	.67	.66	.53	.53
17. Irritability	.78	.77	.77	.74	.62	.62
18. Appetite	.66	.63	.63	.68	.57	.57
19. Concentration	.80	.78	.78	.72	.60	.60
20. Fatigue	.84	.83	.83	.83	.73	.73
21. Libido	.50	.48	.48	.72	.61	.61
factor means						
f1 Cog-Affective		0.00	1.31		0.00	0.97
f2 Somatic-Veg		0.00	0.60		0.00	1.90

Note. f: factor(s). c: class(es). Factor means were fixed at zero in the first class and estimated in the second class, representing standardized differences between classes.