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Heterogeneity in the Latent Structure of PTSD Symptoms Among Canadian Veterans

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The current study used factor mixture modeling to identify heterogeneity (i.e., latent classes) in 2 well-supported models of posttraumatic stress disorder's (PTSD) factor structure. Data were analyzed from a clinical sample of 405 Canadian veterans evaluated for PTSD. Results were consistent with our hypotheses. Each PTSD factor model was best represented by 2 latent classes of participants, differing with respect to PTSD symptom severity. Furthermore, classes were most strongly distinguished by factor scores related to emotional numbing or dysphoria. For both factor models, class membership was significantly predicted by age and depression diagnosis. Implications of these findings are discussed.

Keywords: posttraumatic stress disorder, military veterans, confirmatory factor analysis, factor mixture modeling

Evidence of heterogeneity among trauma-exposed individuals and those with posttraumatic stress disorder (PTSD) has previously been found in cluster-analytic investigations of general distress and personality inventories (e.g., Elhai, Frueh, Davis, Jacobs, & Hamner, 2003; Forbes et al., 2003; Miller, Kaloupek, Dillon, & Keane, 2004), symptom onset and chronicity (e.g., Schnurr, Lunney, Sengupta, & Waelde, 2003), and treatment outcome (e.g., Taylor et al., 2001). Although these studies help to highlight individual differences at the level of observed variables, little is known about such diversity at the latent-variable level.

In one of the few studies to examine latent heterogeneity in PTSD, Breslau, Reboussin, Anthony, and Storr (2005) evaluated observed PTSD symptom data (i.e., PTSD item responses) from two nonclinical community samples. Through latent-class analysis, the authors empirically identified three distinct classes of individuals, corresponding to severity of PTSD-related disturbance (i.e., no disturbance, intermediate disturbance, and pervasive disturbance). The authors also noted qualitative distinctions between classes, with the emotional numbing symptoms of PTSD being more prominent among participants categorized as having pervasive disturbance (Breslau et al., 2005). This latter finding is consistent with previous research (e.g., Foa, Riggs, & Gershuny, 1995), which has suggested that emotional numbing symptoms are of relatively greater importance than other PTSD clusters in distinguishing between those with and without PTSD.

Taken together, the results of these previous studies suggest that (a) it is possible to identify empirically distinct subgroups of individuals reporting symptoms of PTSD, a construct with strong evidence of dimensionality (Broman-Fulks et al., 2006, 2009; Forbes, Haslam, Williams, & Creamer, 2005; Ruscio, Ruscio, & Keane, 2002), and (b) PTSD symptom clusters may vary in terms of their relative importance in distinguishing between these subgroups. Although some support for the former has been found through replication (e.g., Chung & Breslau, 2008), evidence of the latter is less robust, as it is based entirely on observed data from individual symptoms. To gain a greater understanding of the mechanisms that may contribute to greater PTSD severity, symptom data are best analyzed at the latent-factor level, allowing for reliable, error-free measurement (Bollen, 1989).

The past decade has brought numerous confirmatory factor analytic (CFA) investigations into the latent structure of PTSD symptoms. Overwhelmingly, these studies have provided little support for the three-factor PTSD model currently specified in the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev. [*DSM–IV–TR*]; American Psychiatric Association, 2000), which consists of intrusive reexperiencing (Criterion B), avoidance/emotional numbing (Criterion C), and hyperarousal (Criterion D) symptom clusters (see Table 1). Two alternative four-factor models have routinely demonstrated a better fit across numerous studies (for reviews, see Asmundson, Stapleton, & Tay-

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Table 1
Item Mappings for PTSD Models

PTSD diagnostic criteria	Models *DSM–IV–TR*	King	Simms
B1: Intrusive thoughts	I	I	I
B2: Nightmares	I	I	I
B3: Reliving trauma	I	I	I
B4: Emotional cue reactivity	I	I	I
B5: Physiological cue reactivity	I	I	I
C1: Avoidance of thoughts	A/N	A	A
C2: Avoidance of reminders	A/N	A	A
C3: Trauma-related amnesia	A/N	N	D
C4: Loss of interest	A/N	N	D
C5: Feeling detached	A/N	N	D
C6: Feeling numb	A/N	N	D
C7: Hopelessness	A/N	N	D
D1: Difficulty sleeping	H	H	D
D2: Irritable/angry	H	H	D
D3: Difficulty concentrating	H	H	D
D4: Overly alert	H	H	H
D5: Easily startled	H	H	H

Note. PTSD = posttraumatic stress disorder; *DSM–IV–TR* = *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev.); I = intrusion; A = avoidance; N = numbing; D = dysphoria; H = hyperarousal.

lor, 2004; Elhai, Ford, Ruggiero, & Frueh, 2009; Naifeh, Elhai, Kashdan, & Grubaugh, 2008).

The largest volume of empirical support regarding PTSD's factor structure exists for an intercorrelated four-factor model proposed by King and colleagues (King, Leskin, King, & Weathers, 1998), which consists of intrusion, avoidance, numbing, and hyperarousal factors (see Table 1). The King model is identical to the three-factor *DSM–IV–TR* PTSD model but splits Criterion C into two separate factors that distinguish symptoms of active avoidance from those of emotional numbing. This model is generally consistent with theoretical and empirical work suggesting that avoidance and numbing involve distinct mental processes (Asmundson et al., 2004; Foa, Zinbarg, & Rothbaum, 1992).

The second alternative model is an intercorrelated four-factor model proposed by Simms and colleagues (Simms, Watson, & Doebbeling, 2002), which consists of intrusion, avoidance, dysphoria, and hyperarousal factors (see Table 1). The intrusion and avoidance factors are identical to those of the King model, while the dysphoria factor consists of the five Criterion C emotional numbing symptoms and the first three Criterion D hyperarousal symptoms (sleep problems, irritability, and concentration problems). The hyperarousal factor consists of the two remaining Criterion D symptoms: hypervigilance and exaggerated startle response. The Simms model is based on theoretical and empirical work indicating that negative affect (i.e., dysphoria) is a nonspecific component underlying many mood and anxiety disorders (Simms et al., 2002; Watson, 2005).

Studies comparing the King and Simms models have generated mixed results (Elhai, Ford, et al., 2009), and few, if any, consistent demographic, trauma-related, or methodological differences have emerged to help resolve the discrepant findings (Elhai, Engdahl, et al., 2009; Palmieri, Weathers, Difede, & King, 2007). For example, studies of United States military veterans have separately supported both the King (McDonald et al., 2008) and Simms models (Simms et al., 2002) using different samples. In addition, studies using multiple samples have found evidence of structural invariance for both the King (McDonald et al., 2008) and Simms models (Krause, Kaltman, Goodman, & Dutton, 2007). It is important to note that many of the CFA studies comparing the King and Simms models have found that both adequately fit the observed data but that one fits slightly better. Given these findings, use of either model could be reasonably justified based on current evidence.

Thus, in the current study, we chose to evaluate PTSD's heterogeneity from the perspective of both the King and Simms models. To do so, we applied factor mixture modeling (FMM; Lubke & Muthén, 2005) to data from a sample of trauma-exposed Canadian military veterans. FMM is a latent-variable mixture modeling technique (Muthén, 2004, 2008) that combines factor analysis (CFA, in this article's case) and latent-class analysis to model unobserved population heterogeneity within a factor analytic model. In this analytic framework, population heterogeneity is determined through the statistical identification of subpopulations (i.e., classes) for whom a specified factor structure (e.g., the King or Simms PTSD model) fits differently (Lubke & Muthén, 2005). Classes identified using FMM may differ qualitatively (e.g., subtypes of a disorder) or quantitatively (e.g., based on high vs. low symptom severity; Lubke & Muthén, 2005). Our use of a clinical sample, plus FMM's ability to model population heterogeneity based on latent factors (thus accounting for measurement error; Bollen, 1989), distinguishes this study from previous efforts to identify PTSD classes in nonclinical samples using methods that are unable to distinguish true score variance from error variance (e.g., Breslau et al., 2005; Chung & Breslau, 2008). To our knowledge, this is the first application of FMM to the study of PTSD.

Although Breslau et al.'s (2005) latent-class analysis supported a three-class solution, one of those classes was nonsymptomatic (i.e., no disturbance), an unsurprising finding given that their study utilized data from a community sample including a substantial proportion of healthy participants. In the current study, we hypothesized that (a) our clinical sample of military mental health patients was unlikely to produce a nonsymptomatic class and, therefore, two symptomatic classes would provide the optimal solution and (b) the emotional numbing and dysphoria factors of the King and Simms models (respectively), both of which encompass the traditional *DSM–IV–TR* emotional numbing symptoms, would most clearly distinguish between the classes. This second hypothesis is consistent with previous research suggesting that emotional numbing symptoms better distinguish between PTSD-based latent classes (Breslau et al., 2005) and between individuals with and without PTSD (e.g., Foa et al., 1995), relative to other PTSD symptoms.

Method

Participants and Procedure

Data were collected from 408 Canadian veterans with military trauma exposure who consecutively presented for a comprehensive psychiatric assessment between 2000 and 2008. Participants were referred by their medical provider or pension officer to Veterans

Affairs Canada or to a community mental health clinic whereby their evaluations were funded by Veterans Affairs Canada. Institutional review board approval was obtained from the Office of Research Ethics at the University of Western Ontario (London, Ontario, Canada) to conduct a retrospective file review of data gathered in the context of comprehensive psychiatric assessment. All participants were evaluated for PTSD. Furthermore, all interview and self-report instruments (see below) were administered by the same clinician (one of the coauthors: J. Don Richardson). Of the 408 participants for whom some data were available, three were removed because they were not administered one or more of the measures used in this study, leaving an effective sample of 405.

Participants were mostly men (95.56%, $n = 387$), and ranged in age from 22 to 93 years old ($M = 55.84$, $SD = 19.56$). Nearly half had not received a high school diploma (48%), while the rest completed high school (34%), some college (12%), or a bachelor's degree (6%). The majority were not currently working (61.98%, $n = 251$). Most participants were married (74.69%, $n = 301$). Regarding military history, 64% ($n = 259$) served as peacekeepers, 29% ($n = 118$) served in World War II, and 7% ($n = 28$) served in the Korean War. Number of deployments ranged from 0 to 7 ($M = 1.46$, $SD = 1.22$).

Measures

Participant background information. Participants completed a questionnaire inquiring about various demographic (e.g., age, education, marital status, employment) and military (e.g., service era, number of deployments) variables.

PTSD symptoms. The PTSD Checklist (PCL; Weathers, Litz, Herman, Huska, & Keane, 1993) is a widely used (Elhai, Gray, Kashdan, & Franklin, 2005), 17-item self-report measure of PTSD that maps onto *DSM–IV–TR*'s criteria. Items are scored on a 5-point Likert-type scale, with respondents indicating how much they were bothered by each symptom over the past month (1 = *not at all*, 5 = *extremely*). The PCL has demonstrated an internal consistency of .94 (Blanchard, Jones-Alexander, Buckley, & Forneris, 1996; Ruggiero, Del Ben, Scotti, & Rabalais, 2003), test–retest reliability of .88 (Ruggiero et al., 2003), and convergent validity with structured PTSD diagnostic interviews and other PTSD self-report measures (Blanchard et al., 1996; Ruggiero et al., 2003). For this study, we used the PCL—Military Version (PCL–M), which queries PTSD symptoms specifically in relation to prior military experiences and has established psychometric properties with military veterans (Forbes, Creamer, & Biddle, 2001). The PCL–M demonstrated adequate internal consistency in the current study ($\alpha = .91$).

The majority of participants ($n = 377$) were also administered the Clinician-Administered PTSD Scale (CAPS; Blake et al., 1990, 1995), a structured PTSD diagnostic interview. The CAPS assesses the frequency and intensity of the 17 *DSM–IV–TR* PTSD symptoms (plus eight associated symptoms). Frequency items are rated from 0 (*never* or *none/not at all*) to 4 (*daily or almost every day* or *more than 80%*). Intensity items are rated from 0 (*none*) to 4 (*extreme*). The CAPS has adequate interrater reliability (.92–.99), internal consistency (.73–.85), and convergent validity with the Structured Clinical Interview for *DSM–IV* and other established measures of PTSD (Weathers, Keane, & Davidson, 2001). Frequency and intensity ratings are summed for an overall PTSD severity score or can be used to generate a categorical diagnosis. In the current study, a PTSD diagnosis was made based on the frequency ≥ 1/intensity ≥ 2/total score ≥ 65 scoring rule, which requires that both of the following conditions are met: (a) endorsement of at least one intrusion, three avoidance/numbing, and two hyperarousal symptoms (frequency ≥ 1/intensity ≥ 2 for each item), and (b) CAPS total score ≥ 65 (Weathers, Ruscio, & Keane, 1999). Internal consistency of CAPS items in the current study was adequate ($\alpha = .94$).

Depressive symptoms. The Hamilton Depression Scale is a 21-item clinician-rated instrument assessing severity of depressive symptoms (Hamilton, 1967). It has demonstrated interrater reliability ranging from .65 (Maier, Philipp, Heuser, & Schlegel, 1988) to .90 (Hamilton, 1960; Rehm & O'Hara, 1985) and internal consistency ranging from .76 (Rehm & O'Hara, 1985) to .92 (Reynolds & Kobak, 1995). The scale is also highly correlated with other clinician-rated depression instruments (Bech et al., 1975). In the current study, internal consistency was adequate ($\alpha = .84$).

Analysis

We chose the PCL as our primary outcome measure rather than the CAPS because all CAPS interviews were administered by one clinician, precluding an evaluation of interrater reliability. We elected to use the CAPS, instead, as a secondary (and thus, less important) measure of PTSD in analyses of FMM class differences (see Results).

Of the 405 participants, nominal amounts of missing item-level data were present among a handful of participants (1–2 items each, mainly on the Hamilton Depression Scale). We therefore used full information maximum-likelihood (ML) procedures to estimate model parameters based on available data from the PCL's individual items, Hamilton Depression Scale scores, and other covariates (Schafer & Graham, 2002).

We next conducted FMM to model within-group heterogeneity of PTSD's factor structure. This analysis was performed for the King and Simms models separately. For the measurement (CFA) part of the analysis, subject-level data were analyzed for the 17 PTSD items using Mplus 5.1 software (Muthén & Muthén, 2007), with residual error covariances fixed to zero. By default, Mplus scales factor loadings to the first item in each factor. However, given that Factor 3's first item (traumatic amnesia) is generally a weak indicator of PTSD severity (e.g., Breslau et al., 2005), we scaled the emotional numbing (King) and dysphoria (Simms) factors to the item assessing loss of interest. Furthermore, we scaled the hyperarousal factor in each model to the hypervigilance item, so that scaling was consistent on this factor across models. For the mixture part of the analysis, we conducted a latent-class analysis (McLachlan & Peel, 2000; Muthén, 2008) to identify empirically distinct subgroups (i.e., classes) of respondents based on significant differences in their factor scores. Specifically, we tested the hypothesized two-class solution. Several covariates were used to help define the classes, including age, gender, number of military deployments, employment status, and Hamilton depression diagnosis. We used ML estimation with robust standard errors for the analyses, which is robust to nonnormality and generates the Yuan-Bentler chi-square statistic (Yuan & Bentler, 2000).

We report chi-square values and several goodness-of-fit indices for the simple CFAs (i.e., without the mixture component, conducted on the whole sample), including the Tucker-Lewis index (TLI), comparative fit index (CFI), root-mean-square error of approximation (RMSEA), and standardized root-mean-square residual (SRMR). For well-fitting models, Hu and Bentler (1999) recommended TLI/CFI $\geq .95$, RMSEA $\leq .06$, and SRMR $\leq .08$. For analyses containing the mixture component, we report log likelihood values. We also report Bayesian information criterion (BIC) values, a fit index that allows for comparisons between nonnested models, where a 10-point BIC difference indicates a 150:1 likelihood that the model with the smaller value fits best (Raftery, 1995).

Results

PTSD and Depression Data

The mean PCL score was 55.99 ($SD = 14.88$). For the 377 participants who completed the CAPS, the mean score was 69.46 ($SD = 25.25$), and just over 58% met criteria for a PTSD diagnosis. Almost 82% of participants ($n = 331$) met criteria for depression on the Hamilton Depression Scale. Among those meeting CAPS criteria for PTSD, approximately 97% also met criteria for depression.

FMM Results

PCL items were fairly symmetrically distributed; no skewness or kurtosis values were larger than 1.35. For simple CFAs conducted on the entire sample, both the King and Simms models yielded some evidence for an adequate fit (see Table 2). The nearly 30-point difference in BIC values indicates a very strong likelihood that the Simms model is better fitting (Raftery, 1995). Table 3 demonstrates factor loadings and factor intercorrelations for the King and Simms models. It is interesting to note that the models' factor loadings are quite similar to each other, with the exception of the last five items.

Next, we applied the mixture model component to the CFA (separately for the King and Simms models), estimating latent classes of factor scores, with the covariates (described above) specified to predict latent-class membership. In identifying the optimal number of classes from the latent-class analysis, we primarily relied on the Lo-Mendell-Rubin adjusted likelihood ratio test (Lo, Mendell, & Rubin, 2001), with substantial empirical support for identifying a given model with K classes against a model with $K - 1$ classes (Nylund, Asparouhov, & Muthén, 2007). As hypothesized, for the King model, a two-class solution was superior to a one-class solution, adjusted Lo-Mendell-Rubin $2LL_{\mathrm{Diff}}(10) = 271.56$, $p < .001$, with no significant information added after a two-class solution, adjusted Lo-Mendell-Rubin $2LL_{\mathrm{Diff}}(10) = 42.07$, $p > .05$. For the Simms model as well, a two-class solution was superior to a one-class solution, adjusted Lo-Mendell-Rubin $2LL_{\mathrm{Diff}}(10) = 271.84$, $p < .001$, with no significant information added after a two-class solution, adjusted Lo-Mendell-Rubin $2LL_{\mathrm{Diff}}(10) = 34.71$, $p > .05$. The King and Simms model two-class solutions fit the data well, in that entropy (denoting correct classification accuracy) was .874 for the King model, and .867 for the Simms model. Correct class membership prediction was excellent: .97 for the King model and .96–.97 for the Simms model.

Figure 1 demonstrates each latent class's unadjusted, standardized factor means for the King and Simms models, with the more symptomatic class in each model having standardized factor means of zero (for model identification purposes). Qualitatively, the figure suggests that for both the King and Simms models, Class 2 deviates from Class 1 most substantially on the third factor (emotional numbing in the King model, dysphoria in the Simms model). Furthermore, Class 2 differs in the King and Simms models mainly in that, in contrast to Class 1, the hyperarousal factor mean is lower in the King than in the Simms model.

To determine the magnitude of the difference between classes on each factor, we conducted t tests on the adjusted factor scores. There were significant interclass differences on all factors in the King model, with the emotional numbing factor demonstrating the largest effect size: intrusion, $t(403) = -10.90$, $p < .001$, $d = -1.12$; avoidance, $t(403) = -14.35$, $p < .001$, $d = -1.55$; emotional numbing, $t(403) = -44.67$, $p < .001$, $d = -4.70$; and hyperarousal, $t(403) = -28.72$, $p < .001$, $d = -2.96$. Similarly, there were significant interclass differences on all factors in the Simms model, with the dysphoria factor demonstrating the largest effect size: intrusion, $t(403) = -10.64$, $p < .001$, $d = -1.11$; avoidance, $t(403) = -14.37$, $p < .001$, $d = -1.56$; dysphoria, $t(403) = -40.39$, $p < .001$, $d = -4.27$; and hyperarousal, $t(403) = -18.32$, $p < .001$, $d = -1.93$.

The only statistically significant covariates for the King model in predicting Class 1 membership (using logistic regression paths) were age ($B = -0.07$, $SE = .01$, $p < .001$, odds ratio [OR] = .93) and having a Hamilton Depression Scale diagnosis ($B = 5.07$, $SE = .76$, $p < .001$, OR = 159.07). Similarly, for the Simms model, the only significant covariates in predicting Class 1 membership were age ($B = -0.08$, $SE = .02$, $p < .001$, OR = 0.93) and having a Hamilton Depression Scale diagnosis ($B = 5.28$, $SE = .82$, $p < .001$, OR = 196.96).

Due to the strong association between depression and class membership, we examined correlations between the Hamilton

Table 2
Fit Statistics for the King and Simms Models

Model	Yuan-Bentler χ^2 (df)	CFI	TLI	RMSEA	SRMR	BIC
King	289.39 (113)*	.93	.92	.06	.05	20,886.69
Simms	266.42 (113)*	.94	.93	.06	.05	20,858.17

Note. CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root-mean-square error of approximation; SRMR = standardized root-mean-square residual; BIC = Bayesian information criterion.
* $p < .001$.

Table 3
Unstandardized and Stardardized Factor Loadings and Factor Intercorrelations for the King and Simms Models

Parameter estimate	King model		Simms model	
	Unstandardized	Standardized	Unstandardized	Standardized
Factor loadings				
Intrusive thoughts	**1.00**	.74	**1.00**	.74
Nightmares	1.09	.68	1.09	.68
Reliving trauma	1.15	.73	1.16	.73
Emotional cue reactivity	0.94	.67	0.94	.67
Physiological cue reactivity	1.12	.71	1.13	.72
Avoidance of thoughts	**1.00**	.64	**1.00**	.64
Avoidance of reminders	1.30	.76	1.31	.76
Trauma-related amnesia	0.47	.14	0.49	.15
Loss of interest	**1.00**	.44	**1.00**	.45
Feeling detached	1.27	.62	1.24	.59
Feeling numb	1.26	.52	1.23	.52
Hopelessness	0.99	.33	1.00	.35
Difficulty sleeping	0.72	.42	0.77	.31
Irritable/angry	0.86	.51	0.96	.41
Difficulty concentrating	0.84	.52	0.94	.41
Overly alert	**1.00**	.53	**1.00**	.72
Easily startled	0.90	.50	0.92	.70
Factor intercorrelations				
Factors 1–2		.71		.71
Factors 1–3		.47		.58
Factors 1–4		.74		.64
Factors 2–3		.40		.50
Factors 2–4		.63		.53
Factors 3–4		.67		.61

Note. Bold type indicates fixed factor loading. Posttraumatic stress disorder factors are 1 = intrusion; 2 = avoidance; 3 = numbing for the King model, dysphoria for the Simms model; and 4 = hyperarousal.

Depression Scale total score and each PTSD model's factor scores. For the King model, correlations with depression were significant ($p < .01$) and small to moderate in magnitude, ranging from .17 (intrusion) to .33 (emotional numbing). Factors in the Simms model demonstrated a similar pattern of significant correlations with depression ($p < .01$), ranging from .17 (intrusion) to .34 (dysphoria). Given the large interclass differences on emotional numbing and dysphoria, we used t tests for dependent (single-sample) correlations to examine whether depression's correlations with these factors were significantly larger than its correlations with other factors in each model. For the King model, depression was significantly more correlated with emotional numbing than with intrusion, $t(402) = 3.93$, $p < .001$, and avoidance, $t(402) = 2.66$, $p < .01$, but not hyperarousal, $t(402) = 1.60$, $p = .11$. For the Simms model, depression was significantly more correlated with dysphoria than all other factors: intrusion, $t(402) = 4.35$, $p < .001$; avoidance, $t(402) = 2.97$, $p < .01$; and hyperarousal $t(402) = 3.58$, $p < .001$.

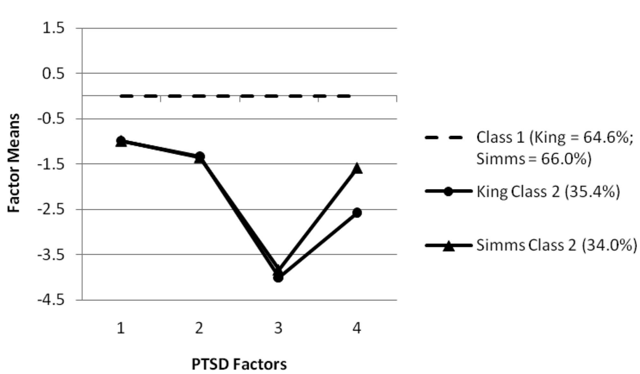

Figure 1. King and Simms models latent-class standardized factor means. Class 1 is the more symptomatic class for the King and Simms models, with means standardized to zero for model identification purposes. Posttraumatic stress disorder (PTSD) factors are 1 = intrusion; 2 = avoidance; 3 = numbing for the King model, dysphoria for the Simms model; and 4 = hyperarousal.

Finally, to evaluate the PCL-derived classes against another measure of PTSD, we examined relations between class membership and CAPS scores for the subset of participants administered the CAPS ($n = 377$). Four participants were missing one CAPS item each. These items were found to be missing completely at random, Little's MCAR (missing completely at random) test $\chi^2(132, N = 377) = 134.06$, $p > .05$ (Little, 1988), and were estimated using ML procedures. For the King model, class membership was significantly associated with CAPS diagnosis, $\chi^2(1, N = 377) = 139.14$, $p < .001$, $\varphi = .61$, with almost 79% of those in Class 1 meeting CAPS criteria for PTSD. There were significant interclass differences on all CAPS subscales (items were summed based on the King model factors), with the emotional numbing subscale demonstrating the largest effect size: intrusion, $t(375) = -7.58$, $p < .001$, $d = -0.81$; avoidance, $t(375) = -5.88$, $p < .001$, $d = -0.65$; emotional numbing, $t(375) = -19.40$, $p < .001$,

$d = -2.17$; and hyperarousal, $t(375) = -14.64$, $p < .001$, $d = -1.58$. For the Simms model, class membership was similarly associated with CAPS diagnosis, $\chi^2(1, N = 377) = 142.36$, $p < .001$, $\varphi = .62$, with almost 79% of those in Class 1 meeting CAPS criteria for PTSD. There were significant interclass differences on all CAPS subscales (items were summed based on the Simms model factors), with the dysphoria subscale demonstrating the largest effect size: intrusion, $t(375) = -7.85$, $p < .001$, $d = -0.84$; avoidance, $t(375) = -6.37$, $p < .001$, $d = -0.71$; dysphoria, $t(375) = -21.43$, $p < .001$, $d = -2.39$; and hyperarousal, $t(375) = -9.52$, $p < .001$, $d = -1.06$.

Discussion

In this study, we applied FMM to data from a sample of Canadian veterans to examine latent factors and external variables associated with heterogeneity in the two most widely supported PTSD factor models. Results of the simple CFA indicate that both the King and Simms models generally provided a good fit to the data across multiple indices. Although differences in fit were minor, the Simms model demonstrated a better fit based on BIC values, which provide a quantifiable measure of goodness-of-fit differences between nonnested models (Raftery, 1995).

As hypothesized, the mixture modeling component of our analyses indicated that both models were best represented by two latent classes that differ in terms of PTSD symptom severity. Previous latent-class analysis studies of PTSD in community samples have supported a three-class solution, with one of the classes identified as nonsymptomatic (Breslau et al., 2005; Chung & Breslau, 2008). By comparison, the current study's clinical sample did not support a third class that was clearly nonsymptomatic. The less symptomatic class of both models (Class 2) had a mean PCL score of 41. This is below the clinical cutoff of 50 (Forbes et al., 2001) but suggests that, on average, participants in Class 2 were not nonsymptomatic. We also found that class membership varied as a function of age and comorbid depression. Specifically, membership in the more symptomatic class of the King model was 7% less likely for every one-year increase in age and 159 times more likely among those with a Hamilton Depression Scale diagnosis. Similarly, membership in the more symptomatic class of the Simms model was 7% less likely for every one-year increase in age and 197 times more likely among those with a Hamilton Depression Scale diagnosis. For the subset of participants with CAPS data, almost 79% of those in the more symptomatic class (Class 1) of each model met CAPS criteria for a PTSD diagnosis.

Also consistent with our hypotheses, Class 1 was most strongly distinguished from the less symptomatic class (Class 2) by scores on their respective third factors (emotional numbing in the King model, dysphoria in the Simms model). Providing support for this pattern across PTSD instruments, similar results were obtained when evaluating interclass differences on observed CAPS scores, with the emotional numbing and dysphoria subscales demonstrating the largest effect sizes. These findings are consistent with previous research demonstrating that several symptoms common to both the emotional numbing and the dysphoria factors are most strongly predictive of a PTSD diagnosis (Foa et al., 1995), as well as greater overall distress, comorbidity, and functional impairment, relative to other PTSD symptoms (e.g., Johnson, Palmieri, Jackson, & Hobfoll, 2007; Kuhn, Blanchard, & Hickling, 2003; Palmieri & Fitzgerald, 2005; Palmieri, Marshall, & Schell, 2007; Simms et al., 2002). It is also consistent with Breslau et al.'s (2005) latent-class analysis of observed PTSD symptom data, in which classes (based on severity of disturbance) were most clearly distinguished by emotional numbing symptoms.

One may question whether our findings of greater interclass differences on the emotional numbing and dysphoria factors are simply due to higher levels of comorbid depression in the more symptomatic class. This possibility is partially supported by the fact that depression was significantly more correlated with emotional numbing and dysphoria than with other factors in their respective models, except for hyperarousal in the King model (possibly due to the symptoms of sleep problems and concentration problems, which it shares with depression). On the other hand, none of the correlations between depression and each model's factor scores were large in magnitude, including those for emotional numbing ($r = .33$) and dysphoria ($r = .34$). This is consistent with previous research suggesting that PTSD and depression are separate constructs and that their high rate of comorbidity cannot be explained entirely by symptom overlap (Blanchard, Buckley, Hickling, & Taylor, 1998; Elhai, Grubaugh, Kashdan, & Frueh, 2008; Ford, Elhai, Ruggiero, & Frueh, 2009). Furthermore, a prospective study of assaulted women found that emotional numbing predicted PTSD severity above and beyond the variance accounted for by depression and dissociation (Feeny, Zoellner, Fitzgibbons, & Foa, 2000). Thus, it seems unlikely that the large interclass differences on emotional numbing and dysphoria can be accounted for by comorbidity alone.

Qualitatively, for the less symptomatic class (Class 2), factor means were similar between the King and Simms models, with the exception of hyperarousal, which was lower in the King model. A key distinction of the Simms hyperarousal factor is that it comprises symptoms that may be considered a more pure representation of posttraumatic hyperarousal (i.e., hypervigilance, exaggerated startle response; Simms et al., 2002). It has been suggested that these symptoms specifically tap fear-based anxious arousal similar to that observed in panic (Watson, 2005). Thus, one advantage of the Simms model is that it potentially highlights fear-based processes that might otherwise be obscured in the King model. This is potentially an important distinction, as several studies have shown that hyperarousal predicts emotional numbing (e.g., Flack, Litz, Hsieh, Kaloupek, & Keane, 2000; Litz et al., 1997; Nugent, Christopher, & Delahanty, 2006; Weems, Saltzman, Reiss, & Carrion, 2003) and, as discussed above, these numbing symptoms (which are included in the dysphoria factor) may in turn be associated with greater distress and impairment.

On the other hand, the Simms hyperarousal factor does not appear to discriminate between classes as well as the King hyperarousal factor (see Figure 1). It may be that the pure hyperarousal symptoms of the Simms model are endorsed too infrequently to be a useful indicator of PTSD severity. By comparison, the King hyperarousal factor includes sleep problems, concentration problems, and irritability, which may be more consistently endorsed among individuals in greater distress. The utility of the King hyperarousal factor, however, might be diminished by the fact that those more frequently endorsed symptoms are common to many psychiatric disorders (Elhai et al., 2008; Ford et al., 2009). Thus, while the King hyperarousal factor may be a robust indicator of general distress, its specificity with respect to PTSD may be low.

This could be particularly relevant in the presence of high comorbidity, such as that observed in the current study. Interestingly, the addition of these symptoms (sleep problems, concentration problems, irritability) in the Simms dysphoria factor did not improve discrimination between classes relative to the King emotional numbing factor. Their lack of incremental value in that context suggests that the remaining dysphoria symptoms (i.e., those comprising the King emotional numbing factor) are of greater relative importance.

Limitations

There are several limitations to the current study. First, consistent with most studies examining PTSD factor models, we utilized a self-report PTSD measure, potentially limiting the validity of participant symptom ratings. Second, we analyzed data from a mostly male sample of Canadian veterans who were seeking either treatment or pension entitlement for a psychiatric condition. Consequently, these results may not generalize to other trauma-exposed populations. It will be important for future studies to examine whether there is a similar degree of heterogeneity in the latent structure of PTSD among individuals exposed to events such as sexual assault, child abuse, and disaster, as well as whether the same factors and external variables are associated with the most severe class. Similarly, our sample reported very high rates of current depression. Although previous research has found that a history of depression is highly comorbid with PTSD in the general population (e.g., 55% lifetime; Elhai et al., 2008), with even higher rates among clinical samples (e.g., up to 95% lifetime, 68% current; Bleich, Koslowsky, Dolev, & Lerer, 1997; Keane & Wolfe, 1990), the occurrence of depression in our sample was especially high. While possibly reflecting factors that are specific to our sample, confidence in this finding must be tempered by the limitations of our depression instrument. Some researchers have harshly discouraged use of the Hamilton Depression Scale on psychometric grounds (Bagby, Ryder, Schuller, & Marshall, 2004), noting significant weaknesses in several areas, including interrater reliability, test–retest reliability, content validity, and factor structure. In the current study, problems with reliability may have been compounded by the fact that all interviews were conducted by the same clinician. Despite this clinician's substantial experience in administering the Hamilton Depression Scale, an evaluation of interrater reliability was not possible. Even though it did not serve as a primary outcome, depression diagnosis was incorporated as a covariate influencing class membership. Thus, any inaccuracies in depression diagnosis (e.g., a slightly high false-positive rate) may have skewed the formation of classes. Finally, while female gender has generally been established as predictor of PTSD severity across several trauma populations (Brewin, Andrews, & Valentine, 2000), it did not emerge as a significant predictor of class membership in our analyses. This may have been due to the imbalance of men and women in our sample, and therefore, future studies should evaluate the effects of gender on class membership in samples where this variable is more evenly distributed.

Conclusions

Previous PTSD factor analytic studies have treated trauma-exposed samples as structurally homogeneous. The results of the current study, however, suggest that it is possible to identify heterogeneity within PTSD at a latent level using FMM. Thus, a more complete understanding of PTSD's structure may necessitate the identification of subgroups for which a particular factor model fits differently. The results also suggest that, for the King and Simms PTSD models, this heterogeneity is most strongly associated with certain factors and external variables. Specifically, the importance of symptoms contained within the emotional numbing and dysphoria factors is becoming more apparent through this and previous studies. With increasing applications of FMM across different trauma-exposed populations and assessment measures, understanding of PTSD's structural diversity will likely increase. This is an important step in identifying the disorder's underlying mechanisms, which will ultimately aid in advancing its conceptualization, measurement, and treatment.

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