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A Meta-Analytic Investigation of the Structure of Posttraumatic Stress Disorder Symptoms

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Abstract

Converging lines of evidence have called into question the validity of conceptualizations of posttraumatic stress disorder (PTSD) based on the *Diagnostic and Statistical Manual of Mental Disorders (DSM)*; American Psychiatric Association, 2000) and suggested alternative structural models of PTSD symptomatology. We conducted a meta-analysis of 40 PTSD studies ($N = 14,827$ participants across studies) that used a *DSM*-based measure to assess PTSD severity. We aggregated correlation matrices across studies and then applied confirmatory factor analysis to the aggregated matrices to test the fit of competing models of PTSD symptomatology that have gained support in the literature. Results indicated that both prominent 4-factor models of PTSD symptomatology yielded good model fit across subsamples of studies; however, the model comprising Intrusions, Avoidance, Hyperarousal, and Dysphoria factors appeared to fit better across studies. Results also indicated that the best fitting models were not moderated by measure or sample type. Results are discussed in the context of structural models of PTSD and implications for the diagnostic nosology.

Keywords

posttraumatic stress disorder; confirmatory factor analysis; meta-analysis; correlation matrices; structural equation modeling

Posttraumatic stress disorder (PTSD) is an anxiety disorder introduced as an official psychiatric disorder with the publication of the third edition of the *Diagnostic and Statistical Manual of Mental Disorders* (American Psychiatric Association [APA], 1980). It currently is characterized in the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev. [*DSM-IV-TR*]; APA, 2000) by three symptom clusters that may occur after experiencing a traumatic event and requires (a) that the event involved actual or threatened death or serious injury to self or others and (b) that the person's response involved intense fear, helplessness, or horror. In addition, *DSM-IV-TR* requires that patients meet at least one of five reexperiencing symptoms (Criterion B), at least three of seven symptoms of avoidance and emotional numbing of general responsiveness (Criterion C), and at least two of five hyperarousal symptoms (Criterion D). However, the *DSM* criteria for PTSD were

generated largely by expert opinion and not by empirical investigations (Buckley, Blanchard, & Hickling, 1998), and the structure of posttrauma symptomatology as implied by the *DSM* has been empirically challenged in recent years by a growing number of structural studies. Questions remain regarding the exact number and nature of dimensions underlying PTSD.

The primary method used to investigate the symptom structure of PTSD has been factor analysis, using both exploratory (EFA) and confirmatory (CFA) variants. EFA is a descriptive technique that does not permit comparisons of relative model fit among competing models (Fabrigar, Wegener, MacCallum, & Strahan, 1999). CFA, on the other hand, permits researchers to specify models a priori and test their relative goodness of fit. As such, CFA methods have been the most commonly used to compare the fit of the *DSM*-based model of PTSD versus alternative models. The basic rationale is that if the *DSM* description of PTSD symptomatology is valid, then factor analytic studies should yield three factors reflective of the three primary symptom clusters identified above. However, this structure has not been supported in the literature (e.g., Baschnagel, O'Connor, Colder, & Hawk, 2005; Elklit & Shevlin, 2007; Krause, Kaltman, Goodman, & Dutton, 2007). Instead, factor analytic studies have provided support for alternative conceptualizations of the factor structure of posttrauma symptomatology.

Specifically, two similar four-factor models (D. W. King, Leskin, King, & Weathers, 1998; Simms, Watson, & Doebbeling, 2002) have gained the most consistent support in recent years. D. W. King et al. (1998) found support for a four-factor model consisting of factors of Reexperiencing, Avoidance, Numbing, and Arousal when analyzing data from 524 male military veterans using the Clinician-Administered PTSD Scale (CAPS; Blake et al., 1990). In contrast, Simms et al. (2002) presented data from a sample of 3,695 Gulf War veterans assessed with the PTSD Checklist (PCL; Weathers, Litz, Herman, Huska, & Keane, 1993). In this study, a four-factor model was supported that contained a Reexperiencing factor, a Hyperarousal factor with two items (hypervigilance, exaggerated startle), an Avoidance factor, and a fourth factor, labeled Dysphoria, in which emotional numbing was broadened and combined with Criteria D1–D3 (i.e., sleep disturbance, irritability, and difficulty concentrating, respectively) to form a factor reflecting general distress or dysphoria. Simms et al. conceptualized the Dysphoria factor as being nonspecific among the mood and anxiety disorders and suggested connections to broader models that delineate general and specific components of depression and anxiety (e.g., Brown, Chorpita, & Barlow, 1998; Clark & Watson, 1991; Mineka, Watson, & Clark, 1998; Prenoveau et al., 2010; Watson, Gamez, & Simms, 2005).

Recent studies examining these models have produced mixed results. Numerous studies have provided support for the Simms et al. (2002) model (e.g., Baschnagel et al., 2005; Boelen, van den Hout, & van den Bout, 2008; Elklit & Shevlin, 2007; Krause et al., 2007; Lancaster, Melka, & Rodriguez, 2009; Milanak & Berenbaum, 2009; Olff, Sijbrandij, Opmeer, Carlier, & Gersons, 2009). For example, Baschnagel et al. (2005) used CFA to examine seven models of PTSD using 528 undergraduate students who were assessed 1 and 3 months after the September 11, 2001, terrorist attacks. The researchers concluded that one-, two-, and three-factor models did not fit the data. Instead, Simms et al.'s four-factor

model best fit the data in this study across time. However, because factor loadings across time were inconsistent and the differences in model fit between the D. W. King et al. (1998) and Simms et al. models were slight, their conclusions about the relative superiority of one model over the other were tentative. In another study, Elklit and Shevlin (2007) conducted a CFA on six PTSD models, including the Simms et al. and King et al. models, on the responses of 1,116 motor vehicle accident participants to the Harvard Trauma Questionnaire (HTQ; Mollica et al., 1992). Their results also indicated that the Simms et al. model provided the best fit to their data. The authors suggested that their results supported the hypothesis that the Dysphoria factor introduced in the Simms et al. model may be a nonspecific component of PTSD because the dysphoria scale correlated more strongly with depression than with all other criterion measures.

In contrast, other studies have suggested that D. W. King et al.'s (1998) model provides the best fit (e.g., Asmundson et al., 2000; DuHamel et al., 2004; McWilliams et al., 2005; Palmieri & Fitzgerald, 2005; Shelby, Golden-Kreutz, & Andersen, 2005). For example, a study examining 429 community members with a history of PTSD found support for King et al.'s four-factor model (McWilliams et al., 2005), as did two studies examining cancer patients (DuHamel et al., 2004; Shelby et al., 2005) and a study examining 1,218 workplace sexual harassment victims (Palmieri & Fitzgerald, 2005). Asmundson et al. (2000) also found support for the King et al. model in a study of 349 primary care patients assessed with the PCL. In this study, Asmundson et al. also found support for a hierarchical model over a correlated four-factor first-order model.

Although most recent studies have supported one of two four-factor models, other less-differentiated models have received some support in the literature. For example, Taylor, Kuch, Koch, Crockett, and Passey (1998) found support for a two-factor solution—with factors labeled Intrusions/Avoidance and Hyperarousal/Numbing—that replicated across two samples. Buckley et al. (1998) conducted a CFA on a sample of 217 motor vehicle accident survivors to try to replicate Taylor et al.'s structure and found a reasonable fit for the model. However, Buckley et al. did not test the fit of alternative models, which limited the strength of their conclusions. Anthony, Lonigan, and Hecht (1999) used CFA to test several PTSD models on a sample of 5,664 hurricane survivors and found optimal fit for an alternative three-factor model consisting of Arousal, Intrusions/Active Avoidance, and Numbing/Passive Avoidance. Cordova, Studts, Hann, Jacobsen, and Andrykowski (2000) found support for the *DSM-IV* (APA, 1994) three-factor model of PTSD in a sample of 142 breast cancer survivors. Unfortunately these researchers also did not compare this model to other factor models of PTSD (i.e., two-, three-, and four-factor models), making it impossible to assess which of the competing hypothesized models best fit this particular data set.

Thus, although the consensus in the current literature is that posttraumatic symptomatology can likely best be explained by a four-factor model (L. A. King, King, Orazem, & Palmieri, 2006), consensus has not yet emerged regarding the exact nature of these four factors. A possible explanation for the discrepant findings in the literature may lie in sampling or measurement differences across structural studies. For example, structural studies typically have been limited to samples reflecting only a single trauma type (e.g., combat veterans) and

one PTSD measure (e.g., PCL or CAPS). Moreover, many studies do not use *DSM*-based measures, making the comparison of structural differences across studies and their relation to the *DSM* structure difficult to assess. As a result, the factor structure identified by a given study may be specific to the characteristics inherent in that particular study, which runs counter to the recommendations of numerous PTSD researchers who have noted the importance of assessing not only differences among trauma patients, such as such culture, age, and gender (Marshall, 2004; Norris, Perilla, & Murphy, 2001), but also differences among PTSD measures (L. A. King et al., 2006; McWilliams et al., 2005).

Furthermore, little consideration has been given to testing higher order and bifactor versions of these models, particularly in light of the importance of such comparisons to understanding the relations among symptom groupings of a psychological construct (e.g., Zinbarg, Yovel, Revelle, & McDonald, 2006). For example, examining a higher order version of these models would shed light on whether PTSD symptom clusters should be subsumed within an underlying general PTSD factor or are better understood as correlated but distinct dimensions of psychological functioning. Indeed, the organization of PTSD in the *DSM* implies that symptoms should be subsumed under a unitary PTSD construct with correlated symptom clusters (e.g., reexperiencing, hyperarousal clusters, etc.). Similarly, studying a bifactor version of the models (Gibbons et al., 2007; Gibbons & Hedeker, 1992; Holzinger & Swineford, 1937)—in which PTSD symptoms are permitted to load on both a general factor and on one of several orthogonal symptom factors—would be novel in the PTSD literature and has been supported as a parsimonious way to model depression and anxiety symptoms in previous investigations (e.g., Simms, Gros, Watson, O'Hara, 2008).¹ Bifactor models provide a compelling method for estimating the relative influence of nonspecific factors (i.e., a general PTSD factor) versus specific factors (e.g., Intrusions, Avoidance, etc.) on individual symptoms. In the case of PTSD, a well-fitting bifactor model would suggest the presence of a strong nonspecific factor that may help explain the high rates of comorbidity observed between PTSD and other mood and anxiety disorders.

Structural Differences Across Measures

Research evaluating structural invariance across PTSD measures largely is lacking in the literature. However, in one notable study (Palmieri, Weathers, Difede, & King, 2007), researchers conducted a series of CFAs on the PCL and the CAPS responses of 2,960 utility workers exposed to the World Trade Center ground zero. The researchers assessed the fit of several prominent structural models to each of these measures, including the D. W. King et al. (1998) and Simms et al. (2002) models. Examining each measure individually, the researchers found that CFAs conducted on the PCL responses supported the Simms et al. model, whereas CFAs conducted on the CAPS responses supported the King et al. model. However, in a separate analysis, the researchers found that the Simms et al. model was slightly superior to the King et al. model after accounting for instrument type with method

¹The bifactor model is a restricted version of a more generalized hierarchical model in which individual symptoms, in addition to loading on a general factor, may load on more than one specific factor. In the present study, we adopted the bifactor constraint because (a) it is computationally less complex and thus more easily estimable and (b) we had no a priori bases for assigning symptoms to multiple specific factors.

factors. These results suggest that some of the heterogeneity observed among PTSD factor analytic results may be attributable to different PTSD measures used across studies.

Structural Differences Across Sample Types

Another potential moderator of PTSD symptom structure is sample type. A number of factors have been proposed to account for possible structural invariance across samples and may influence the reporting and experiencing of trauma symptomatology, including culture, gender, and type of trauma experienced (Norris et al., 2001). Although two recent studies have demonstrated factorial invariance of the D. W. King et al. (1998) four-factor model across English- and Spanish-speaking groups (Marshall, 2004; Norris et al., 2001), research examining the structural invariance of PTSD across multiple samples generally is lacking.

Notably, however, in two samples consisting of deployed veterans of the Persian Gulf War and comparable nondeployed military controls, Simms et al. (2002) found that their four-factor model provided the best fit in both samples. Moreover, the authors found that a subset of deployed veterans who met Criterion A for PTSD also showed the same symptom structure. These results provide evidence that PTSD symptom structure may not be as severely impacted by sample type as some researchers have theorized. Similarly, a recent study by McDonald et al. (2008) supported the conclusion of structural invariance of PTSD symptoms across three veteran samples. This study compared six models and found the strongest support for the D. W. King et al. (1998) model across all three samples, leading the authors to suggest that the three symptoms associated with hyperarousal in the *DSM*-based and King et al. models may have different etiologies in PTSD and depression. Specifically, the authors suggested that sleep disturbance for an individual with PTSD may be related to hyperarousal symptoms, whereas an individual with depression may lose sleep due to ruminative thoughts, and that these symptoms would be related to the experience of emotional numbing and anhedonia. As further evidence for this contention, the authors suggested that studies supporting the King et al. model examined samples with a high rate of PTSD (e.g., Palmieri & Fitzgerald, 2005), whereas the studies supporting the Simms et al. model examined nonclinical samples (e.g., Baschnagel et al., 2005).

However, a recent study by Krause et al. (2007) does not support this contention. Krause et al. tested six competing PTSD models in the first CFA study to examine the factor structure of PTSD in a group of women exposed to intimate partner violence. These researchers found that the Simms et al. (2002) model fit better in their sample than every other model, including the D. W. King et al. (1998) model. In addition, the Simms et al. model exhibited structural invariance when participants were assessed at a 1-year follow-up. Thus, in addition to the veterans assessed in Simms et al.'s study, this study provided evidence that clinical samples with PTSD diagnoses may also exhibit a PTSD structure more similar to the Simms et al. model.²

²Krause et al. (2007) reported data on models with factor correlations fully constrained but did not evaluate structural invariance in the less constrained models (e.g., metric vs. configural invariance models).

Current Study

The structural studies conducted to date generally have supported either the Simms et al. (2002) or D. W. King et al. (1998) four-factor models of PTSD and generally have failed to support alternative models of PTSD, including the *DSM*-based three-factor model. However, consensus has not yet emerged regarding the exact nature of these four factors. Moreover, several recent studies have suggested possible moderators of PTSD symptom structure. In the present study, we conducted a meta-analytic factor analysis to determine which four-factor model provides the best fit after aggregating across a large sampling of PTSD studies. Moreover, we studied potential moderators of PTSD symptom structure by conducting follow-up analyses based on measure type and trauma type. A meta-analysis of this type is novel in the PTSD literature and has the potential to bring much-needed clarity to the understanding of PTSD structure. To accomplish our goals, we aggregated the correlation matrices from 40 PTSD studies that used a variety of *DSM*-based PTSD measures on a number of sample types. We then performed a series of CFAs on the aggregated correlation matrices to determine the best fitting model overall and across different measures and sample types.

Method

Studies Included in the Meta-Analysis

In the present study, our main purpose was to identify the underlying structure of PTSD symptomatology by conducting a meta-analysis on studies that used *DSM*-based PTSD measures. The first step was to obtain the correlation matrices of studies in which participants were assessed with respect to 17 symptom criteria for PTSD listed in the *DSM*. Thus, we limited our analysis to studies that used *DSM*-based PTSD measures. These measures included the CAPS, PCL, HTQ, Posttraumatic Diagnostic Scale (Foa, Cashman, Jaycox, & Perry, 1997), Screen for Posttraumatic Stress Symptoms (Carlson, 2001), Davidson Trauma Scale (Davidson et al., 1997), Modified PTSD Symptom Scale (Falsetti, Resnick, Resick, & Kilpatrick, 1993), and PTSD Symptom Scale (Foa, Riggs, Dancu, & Rothbaum, 1993). The matrices obtained consisted of the interitem correlations among the 17 PTSD symptom criteria as assessed by these measures.

To locate relevant studies, we used the names of the listed *DSM*-based PTSD measures, their abbreviations, and other phrases (e.g., *PTSD*, *factor analysis*, *symptom structure*) as keywords in a PsycINFO search. Our only criteria for including a study in our analysis were that the study used a *DSM*-based PTSD measure and that the respective researchers agreed to send the correlation matrix from the study; we did not limit our search to structural studies. Because most studies did not include correlation matrices in their reports, it was necessary to contact the researchers directly via e-mail to request the necessary data. All researchers who responded and sent correlation matrices were included in the meta-analysis. To ensure as broad a sampling of research as possible, we also requested correlation matrices from unpublished studies. Out of an initial 414 e-mail solicitations, 44 correlation matrices were obtained for the purposes of this analysis. Six of these studies were not from independent samples and were therefore eliminated from the analysis, yielding a sample size of 38 correlation matrices. To these we added two matrices from Yufik and Simms's (2010)

unpublished studies of PTSD symptoms in veterans and victims of interpersonal violence (IPV), yielding a final sample size of 40 correlation matrices (9.6%). The studies were coded by sample type and measure. In four cases, researchers we contacted sent the raw data sets from their studies, and we computed the correlation matrices from these data. In one case, researchers sent the covariance matrix and standard deviations from their study, and we computed the correlation matrix from this information. All data entry was conducted by us or by research assistants, and the data entry from each study was verified by at least one additional researcher.

A listing of all included studies appears in Table 1. The total effective sample size across studies was 14,827 participants. The two most prevalent measures used across studies were the PCL (18 studies; $n = 8,568$) and the CAPS (eight studies; $n = 1,042$). The two most common trauma types included combat experience (10 studies; $n = 7,461$) and IPV (12 studies; $n = 2,995$).

Procedure

We meta-analytically combined and analyzed the 40 correlation matrices with a two-stage structural equation modeling procedure (TSSEM; Cheung & Chan, 2005) designed to specifically combine correlation matrices for analysis with structural equation modeling (SEM) and to address the statistical weaknesses of previous approaches to meta-analytic CFA and SEM studies with correlation matrices (e.g., lack of matrix homogeneity due to sampling or metric differences across studies, which may result in incorrect values of parameter estimates and test statistics; Cudeck, 1989). Cheung and Chan (2005) provided software to implement a TSSEM analysis in combination with LISREL (Jöreskog & Sörbom, 1996). In the first stage of TSSEM, a multiple-group CFA model is used to test the homogeneity of a set of correlation matrices and to statistically pool the matrices. In the second stage of TSSEM, the pooled correlation matrix is used to fit structural models with the asymptotic covariance matrix of the pooled correlation matrix by the weighted least squares method. In all lower order models, factors were permitted to correlate, which is consistent with all PTSD structural studies of this type (e.g., Palmieri & Fitzgerald, 2005; Palmieri, Weathers, et al., 2007). Across a series of simulations, the TSSEM method was superior in applying SEM to meta-analytically combined correlation matrices when compared with several widely used meta-analytic procedures (Cheung & Chan, 2005).

In the present study, five prominent models of PTSD structure were compared. Table 2 includes the symptom mapping for each model. Model 1 is a one-factor model included for comparison purposes to determine whether all 17 PTSD symptoms can be adequately modeled by a single general factor. Model 2 is a two-factor model identified by Taylor et al. (1998) in which intrusions (Items B1–B5) and avoidance (Items C1–C2) form one factor and hyperarousal (Items D1–D5) and emotional numbing (Items C3–C7) form a second dimension. Model 3 represents the symptom structure delineated in the *DSM-IV*. We also tested the two most prominent four-factor models. Model 4a is based on D. W. King et al.'s (1998) four-factor model that maintains a traditional Emotional Numbing factor. Model 4b is based on Simms et al.'s (2002) alternative four-factor model described earlier. This model differs from Model 4a in that the Hyperarousal factor consists of only two items (D4 and

D5), and the remaining three Criterion D symptoms (D1, D2, and D3) load together with C3–C7 to form a broader Dysphoria factor.

In addition, we tested higher order and bifactor versions of the best fitting models. In the higher order model, all symptom factors were modeled as loading on a general PTSD factor rather than as correlated lower order factors. For the bifactor model, all individual symptoms were modeled to simultaneously load on both a general factor as well as one of several specific symptom factors that correspond to the symptom mappings in Table 2. Finally, we tested several subsamples to examine if model fit was moderated by sample or measure type. Specifically, we examined the PCL civilian and military versions, the CAPS, IPV victims with and without substance abuse, and veterans who did or did not participate in the Gulf War. On the basis of the inconclusive state of the literature regarding the superiority of either four-factor model, we hypothesized that both models would yield good overall model fit; however, following Palmieri, Weathers, et al., (2007), we hypothesized that the Simms et al. (2002) model would fit better for the PCL analyses and the D. W. King et al. (1998) model would fit better for the CAPS analyses.

To assess model superiority, we considered six indices of goodness of fit: the standardized root-mean-square residual (SRMR), the root-mean-square error of approximation (RMSEA), the Bentler-Bonnet normed fit index (NFI), the comparative fit index (CFI), the goodness-of-fit index (GFI), and the Bayesian information criterion (BIC; see Hu & Bentler, 1999, for additional information about these indicators). The BIC was not available through the LISREL program and was calculated as follows: $BIC = \chi^2 + [k \times \ln(N)]$, where k = the number of free parameters and N = the sample size. Although no strict criteria exist for evaluating the fit indices, generally accepted guidelines suggest that multiple indicators of goodness of fit provide a more reliable evaluation of model superiority. Furthermore, Hu and Bentler (1999) suggested that model fit is acceptable if SRMR is .08 or less, RMSEA is .06 or less, and the NFI, CFI, and GFI are .95 or greater. BIC is an index that balances model fit with model parsimony; lower BIC values represent better fit (Gregorich, 2006). Descriptively, a BIC difference of 0–2 equals positive evidence, 6–10 equals strong evidence, and > 10 equals very strong evidence in favor of the model with the lower BIC value (Raftery, 1996).

Results

Stage 1 TSSEM Analyses

Fit indices for the Stage 1 TSSEM analysis appear in Table 3. These values for the combined sample suggested heterogeneity across all matrices when pooled together and, thus, that relatively homogeneous subsamples should be identified and tested. According to Cheung and Chan (2005), it is desirable to parse samples into subgroups that produce relatively homogeneous samples and then to subject these subgroups to Stage 2 analysis of TSSEM. However, due to the large sample size across multiple studies, ideal fit indices (e.g., CFI above .95) would not be expected, and it is recommended that the best indicator of fit with large sample sizes is RMSEA (Rigdon, 1996). Thus, because previous PTSD research has suggested evidence of structural invariance across measures and sample types (e.g., L. A. King et al., 2006; Marshall, 2004; McWilliams et al., 2005; Norris et al., 2001),

we studied whether Stage 1 model fit was improved by rationally selecting subsamples based on measures and sample types. For the measure-based analyses, we compared the fit of each model with correlation matrices aggregated from studies using the military and civilian versions of the PCL and the CAPS because they were the most prevalent measures used in the studies we sampled. Although several other *DSM*-based measures were used across studies, these did not constitute a sufficient number with which to conduct a comparison across measures. Eighteen of the studies included in the meta-analysis used the PCL, and eight included in the analysis used the CAPS.

The most common trauma types included in our sampled studies, and thus the focus of the trauma type subsample analyses, were victims of IPV (12 studies) and combat experience (10 studies). However, differences existed between the type of veterans and IPV victims sampled in each of the studies. For example, veterans varied with respect to the war in which they had served, length of deployment, and severity of trauma experienced. IPV victims varied in type of assault (i.e., sexual assault vs. domestic violence), type of victim (i.e., college student vs. substance-abusing community member), length of abuse, and severity of trauma.

We followed the same procedures described above to test the fit of the proposed PTSD models using the TSSEM procedure. Results of the Stage 1 subsample analyses indicated that the most homogeneous groups (i.e., the subgroups with the best Stage 1 fit indices) included the studies sorted by the military and civilian versions of the PCL, studies that used the CAPS, IPV studies sorted by substance-abusing victims and non-substance abusers, and studies with veteran participants sorted by veterans of the Gulf War and non-Gulf War veterans. Most fit indices for these analyses ranged from adequate to excellent for the Stage 1 TSSEM (RMSEAs < .10, SRMRs < .11, CFIs > .79, GFIs > .79), suggesting that these aggregated correlation matrices are reasonably homogeneous and may be used for the Stage 2 TSSEM analyses.

Stage 2 TSSEM Analyses

Stage 2 TSSEM was conducted on the combined sample as well as the subsamples identified above.³ The results for the combined sample and subsamples appear in Tables 4 and 5, respectively. Across the combined matrices analysis, Models 4a and 4b provided the best overall goodness of fit, stronger than all other models. Moreover, the fit values for Models 4a and 4b were identical except for three indices—BIC, SRMR, and RMSEA—on which Model 4b yielded slightly but consistently better fit than Model 4a. Both Models 4a and 4b yielded fit values within the adequate to excellent range, whereas the other models produced indices that were less than adequate in at least one fit index.

³Despite the evidence of matrix heterogeneity for the combined sample, we opted nevertheless to run and report the Stage 2 analyses in the combined sample results for two reasons. First, the homogeneous sub-samples did not include all samples we obtained, and thus we wanted to include at least one set of analyses that fully reflected the breadth of studies in our sample. Second, we wished to assess whether the pattern of results was similar or differed substantially across aggregated correlation matrices varying in their levels of homogeneity. If, for example, a similar pattern emerged across all or most aggregated matrices, the impact of matrix heterogeneity of symptom structure would seem to be minimal in this study.

We compared orthogonal and oblique versions of the Simms et al. (2002) and D. W. King et al. (1998) models and found that the oblique versions fit significantly better across both models, which suggests that higher order factors are present (Gorsuch, 1983).⁴ As such, we also tested higher order and bifactor versions of Models 4a and 4b. Across both models, the higher order and bifactor versions resulted in poorer SRMA, RMSEA, and BIC fit values than did the lower order models, and thus, we considered only the correlated lower order factor versions of Models 4a and 4b in the subsequent subsample analyses. Similar to the combined sample, the subsample analyses revealed that both Models 4a and 4b fit each of the sample and measure groupings, with fit indices largely in the excellent range. For several of the subsamples, Model 4b demonstrated a marginally better fit than Model 4a on RMSEA values. Notably, on BIC values, Model 4b demonstrated substantially improved fit when compared to Model 4a in all cases but one. The lone exception to this pattern was the non-substance-abusing IPV group, which yielded fit values that were nearly identical for both models across all fit indices.

Discussion

Our study is the first attempt to perform a meta-analysis on the symptom structure of PTSD. Previous work has been limited to single studies characterized by limited generalizability across different PTSD measures and trauma types. Moreover, our analysis permitted us to study whether PTSD structure varies as a function of measure or trauma type. Finally, we simultaneously examined the relative fit of both higher and lower order versions of the best fitting models, the results of which have implications for the way PTSD symptoms are described and classified in the *DSM*. Because both the higher order and lower order models were supported in our analyses, we discuss the implications of both sets of models separately.

Lower Order Model Analyses

Our results provide support for the superiority of both four-factor models over the less differentiated models, including a single-factor model, Taylor et al.'s (1998) two-factor model, and the three-factor model implied by the current *DSM* criteria. In addition, although both four-factor models fit the data well across all subsample groupings, our results consistently revealed that Simms et al.'s (2002) four-factor model fit better than D. W. King et al.'s (1998) model in all analyses except for the non-substance-abusing IPV subsample, in which all fit values were nearly identical across both models.

This finding is particularly noteworthy given that structural studies supporting the D. W. King et al. (1998) model are overrepresented in our sample: Six of the included correlation matrices came from structural studies supporting King et al.'s model (Asmundson et al., 2000; DuHamel et al., 2004; Marshall, 2004; Palmieri & Fitzgerald, 2005; Palmieri, Marshall, & Schell, 2007), whereas three of the included correlation matrices came from structural studies supporting Simms et al.'s (2002) model (Baschnagel et al., 2005; Krause et

⁴The fit indices for the orthogonal version of the D. W. King et al. (1998) model were as follows: NFI = .89, GFI = .89, CFI = .89, RMSEA = .15, SRMR = .35. The fit indices for the orthogonal version of the Simms et al. (2002) model were as follows: NFI = .91, GFI = .91, CFI = .91, RMSEA = .13, SRMR = .34. Results for the oblique versions of these models are presented in Table 4.

al., 2007; Simms et al., 2002). To assess the status of the larger literature for support favoring the King et al. and Simms et al. models, we reviewed the literature for structural studies by using keywords related to PTSD and CFA and other phrases (e.g., *factor analysis*, *symptom structure*) in a PsycINFO search.⁵ Of the structural studies we identified, 12 reported support for King et al.'s model (Andrews, Joseph, Shevlin, & Troop, 2006; Asmundson et al., 2000; Asmundson, Wright, McCreary, & Pedlar, 2003; Cox, Mota, Clara, & Asmundson, 2008; DuHamel et al., 2004; D. W. King et al., 1998; Marshall, 2004; McDonald et al., 2008; McWilliams et al., 2005; Palmieri & Fitzgerald, 2005; Palmieri, Marshall, & Schell, 2007; Schinka, Brown, Borenstein, & Mortimer, 2007), whereas nine studies reported support for Simms et al.'s model (Armour & Shevlin, 2010; Baschnagel et al., 2005; Boelen et al., 2008; Elklit & Shevlin, 2007; Krause et al., 2007; Olff et al., 2009; Palmieri, Weathers, et al., 2007; Shevlin, McBride, Armour, & Adamson, 2009; Simms et al., 2002). Thus, although the extant structural studies slightly favor King et al.'s model in number, the present findings suggest that data extracted from the broader PTSD literature appear to favor Simms et al.'s model when meta-analytically combining data sets across studies. The remaining included studies were not structural in nature, and thus, those authors did not draw conclusions about the relative fits of the structural models tested in the present study. However, we have no reason to believe that the nonstructural correlation matrices we received are biased in support of either four-factor model.

Since it was not possible to include every structural study in the larger literature in our analysis, the difference in fit between the models in our analysis may not be a precise reflection of the larger literature. Specifically, the difference in fit between the D. W. King et al. (1998) and Simms et al. (2002) models may be greater than reflected in our analysis because the proportions in our study do not reflect the larger literature. Specifically, the Simms et al. model is underrepresented by a ratio of 2:1 in our sample (in contrast to a ratio of 4:3 in the larger literature). Thus, it is possible that the differences in fit may be greater when taking into account studies not included in our analysis.

These findings suggest several implications. First, the findings provide some support for the literature that suggests that emotional numbing may not be a distinct part of PTSD as it currently is defined in the nosology but may rather be subsumed under a broader, nonspecific Dysphoria factor that combines symptoms traditionally associated with emotional numbing (i.e., Criteria C2–C7) with the Criterion D symptoms of sleep disturbance, irritability, and difficulty concentrating. Several studies have supported this distinction. For example, Litz, Orsillo, Kaloupek, and Weathers (2000) found that veterans with PTSD exhibited limited emotional responses to positive valenced cues. The researchers concluded that this response was similar to anhedonia symptoms found in depressive disorders. In addition, Kashdan, Elhai, and Frueh (2006) found that symptoms of emotional numbing increased the likelihood that combat veterans would be diagnosed with a depressive disorder.

⁵It is also important to note that although we conducted a thorough review of the literature, there may be additional structural studies that we may have missed or that were published after our search.

Thus, the emergence of a nonspecific Dysphoria factor across structural studies provides further evidence that the emotional numbing criteria of PTSD may best be conceptualized as a nonspecific component of anxious and depressive symptomatology (e.g., Clark & Watson, 1991; Mineka et al., 1998; Simms et al., 2002). However, because the D. W. King et al. (1998) model also resulted in largely excellent fit indices and because our sampling of relevant studies was not exhaustive, firm conclusions regarding the relative importance of dysphoria versus emotional numbing in PTSD symptom structure are not possible from these results. Notably, it is possible that the failure of emotional numbing to emerge as a coherent construct in this and other structural studies may be a matter of the specific criteria used to represent the construct in the *DSM* criteria. Future studies are needed to determine whether additional symptom criteria can be added to better differentiate numbing from nonspecific dysphoria.

Higher Order Model Analyses

Although the lower order models fit the data better in an absolute sense, the higher order models provided a good fit and, importantly, account for the high correlations of the factors in the lower order models. It also should be noted that the poorer fit values for the higher order and bifactor models are somewhat expectable. In the higher order case, for example, the model must account for the six independent correlations among the symptom factors via the specification of four parameters (i.e., the loadings of the four group factors on the general factor). All things being equal, these constraints put the higher order model at a disadvantage when compared with the lower order model (e.g., Marsh & Hocevar, 1985).

Thus, given the relatively good fit indices in the higher order models tested in our analyses in addition to the high correlations among the factors in both models as presented in Figures 1 and 2, these results indicate the presence of a unitary factor of PTSD. These results may also explain, in part, the ongoing support for both the D. W. King et al. (1998) and Simms et al. (2002) models in the literature. For example, if the unique factors of each of the models (i.e., the Dysphoria, Hyperarousal, and Numbing factors) are each highly correlated with one another and with each of the other PTSD symptom clusters, then it is likely that both of these models will continue to result in good fit indices across structural studies.

Furthermore, our results suggest that the distinctions between lower order symptom clusters may be better determined by practical than by statistical considerations. If all symptom clusters correlate highly with one another and are largely subsumed under a global PTSD construct, the debate over whether the unique D. W. King et al. (1998) factors are superior to the unique Simms et al. (2002) factors can be approached by examining which is most useful in a particular setting. Given that the dysphoria symptom cluster may help explain PTSD's high comorbidity with depressive disorders, the Simms et al. conceptualization may prove to be more useful with a subtype of trauma that may be prone to develop depressive symptoms, while the King et al. model may be more useful with a subset of trauma whose salient characteristic is numbing. One hypothesis for future research posits that hyperarousal and/or reexperiencing symptoms may be more applicable to psychological functioning immediately following a trauma, whereas dysphoria/numbing symptoms may be more

salient after a significant amount of time has passed after a trauma (Pietrzak, Goldstein, Malley, Rivers, & Southwick, 2010).

Further Implications

The results of the present study also suggest that PTSD structure does not appear to vary as a function of the measures used or trauma types assessed in this analysis. Although the subsample analyses indicated that the D. W. King et al. (1998) and Simms et al. (2002) models both fit well across measures and sample types, the Simms et al. model yielded slightly better fit across many of the fit indices and substantially better fit according to the parsimony-adjusted BIC value. The relative consistency across sample types and measures suggests that the Simms et al. model better reflects the structure underlying the PTSD criteria described by the *DSM-IV* when testing the lower order models. These results largely are in agreement with other CFA studies that have failed to show a moderating effect of sample type on the structure of PTSD symptoms (e.g., Krause et al., 2007; McDonald et al., 2008; Simms et al., 2002). On the other hand, our measure subsample results are partially inconsistent with the only other CFA study to assess the moderating effect of PTSD measure type (Palmieri, Weathers, et al., 2007), which found that King et al.'s model fit better for the CAPS and Simms et al.'s model fit better for the PCL. In contrast, our results suggest that Simms et al.'s model fit somewhat better than the King et al. model in both the CAPS- and PCL-based analyses. However, given the limited number of CFA studies to date assessing measure type, much more research examining this potential moderator is needed. In particular, future work is needed to replicate the present findings and to extend this methodology to other common PTSD measures.

The findings also have implications for the description of PTSD in future versions of the *DSM*. Consistent with most previous studies, the three-factor model currently delineated in *DSM-IV* received minimal support in all of our analyses and consistently fit less well than both alternative four-factor models as well as the higher order and hierarchical models we tested. In particular, the present study provides further evidence that the current description of PTSD in the next edition of the *DSM* should to be revised to reflect four distinct factors that may be subsumed within a single, unitary PTSD factor. However, our results indicating that both higher order and lower order models provided a good fit should be considered in light of certain restrictions. First, we restricted our higher order and hierarchical tests to models with only a single general factor. It is possible that multiple higher order factors may better explain the covariation among the lower order symptom factors. Second, although lower order models provided a better fit, statistical considerations may place higher order and hierarchical models at a disadvantage when compared to comparable lower order models comprising correlated factors (e.g., Marsh & Hocevar, 1985). Future studies are needed to replicate the present higher order and bifactor results and to examine other potentially meaningful higher order models.

Finally, although our study provides the most consistent support for the Reexperiencing, Avoidance, Hyperarousal, and Dysphoria factors of the Simms et al. (2002) model, the generally excellent fit values of the D. W. King et al. (1998) model suggest that it too is a compelling alternative to consider for *DSM-V*. On the basis of the present results and

conclusions, the most important remaining questions for future structural PTSD research are to study (a) the exact nature of the Emotional Numbing and/or Dysphoria factors across the competing four-factor models and (b) the optimal higher order or hierarchical arrangement of PTSD-relevant factors as well as the implications of such for the diagnostic nosology.

Limitations and Conclusions

Of course, our results and conclusions must be considered in light of several caveats. First, the studies included in the meta-analysis represent a sampling of studies that used *DSM*-based PTSD measures based on the availability of suitable correlation matrices and the willingness of researchers to provide the data. There may be important structural data relevant to the models tested that were not included in the meta-analysis because the correlation matrices were not made available to us. Thus, the difference in fit between the models tested in our analysis may not be a precise reflection of the larger literature.

Second, the measure- and sample-based analyses conducted in this study reflected the most common measures and sample types of the studies provided to us and therefore may also not be a precise reflection of the proportion of the most common measures and samples in the literature. For instance, the published literature largely reflects studies relying on the CAPS and PCL. Although our analysis included a somewhat larger proportion of studies using other measures than is found in the literature, the CAPS and PCL remained the most common measures in our study (26 out of the 40 studies used the CAPS or PCL). Moreover, in analyses comparing measures used, the fit indices of the CAPS and PCL as reported in Table 5 were similar to the fit indices reported for the combined data in Table 4. Therefore, it seems unlikely that the inclusion of studies utilizing measures other than the CAPS or PCL resulted in any negative impact on our results (i.e., the inclusion of the other measures was unlikely to alter the fit of the models tested). It will be important for future research to replicate these results and assess structural invariance across other PTSD measures and trauma groups that were not adequately sampled in the present study (e.g., motor vehicle accidents, terrorism exposure, sexual assault, etc.) and that represent important trauma groups assessed in the PTSD literature. In particular, it will be important for future studies to examine gender differences, an analysis not possible in the current study because of the inadequate number of studies in the sample with female participants.

Third, the samples assessed in this study for the trauma-type moderation analyses (i.e., combat exposure and IPV participants) each represented combinations of diverse samples that varied on a number of factors, such as trauma severity and type of trauma (i.e., varying forms of both IPV and combat exposure). For the purposes of the meta-analysis, it was necessary to aggregate these groups to perform Stage 2 analysis and test the various PTSD models on the data. However, future research should more closely examine subsets of these groups to better understand the variables that may moderate the factor structure of PTSD.

Fourth, future meta-analytic studies aggregating across PTSD studies not included in the present study—including additional unpublished data—would help to cross-validate the present results and address the remaining structural questions identified above.

Fifth, although the fit indices for the Stage 1 TSSEM analysis were adequate, they were not uniformly in the excellent range. It will be important for future meta-analytic studies of PTSD using TSSEM to ensure that aggregated correlation matrices are sufficiently homogeneous.

Finally, it is important to note that because our study included only *DSM*-based measures, our results apply only to the 17 *DSM*-based PTSD symptoms rather than to the universe of all possible posttrauma symptoms. It is likely that other symptoms not currently represented in the *DSM* criteria for PTSD (e.g., some dissociative symptoms, substance abuse, emotional dysregulation) are important to a complete understanding of posttrauma sequelae and thus need to be considered in future structural PTSD work (e.g., Bryant, 2007). In addition, it is possible that the few purported numbing symptoms in the *DSM* do not adequately operationalize this construct. Thus, future studies are needed to assess the factor structure of PTSD with non-*DSM*-based symptoms as well as additional symptoms of numbing, particularly in light of our finding that the D. W. King et al. (1998) model provided a good overall fit to our data.

In conclusion, our findings provide important information in light of calls to clarify the best fitting structure of posttraumatic symptomatology and suggest that the TSSEM approach to meta-analysis may provide an invaluable methodology to further clarify this question. The robustness of Simms et al.'s (2002) and D. W. King et al.'s (1998) models in our meta-analysis agrees with most of the literature, which posits that four factors underlie PTSD symptomatology.

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References

References marked with an asterisk indicate studies included in the meta-analysis.

- American Psychiatric Association. Diagnostic and statistical manual of mental disorders. 3rd. Washington, DC: Author; 1980.
- American Psychiatric Association. Diagnostic and statistical manual of mental disorders. 4th. Washington, DC: Author; 1994.
- American Psychiatric Association. Diagnostic and statistical manual of mental disorders. 4th. Washington, DC: Author; 2000.
- Andrews L, Joseph S, Shevlin M, Troop N. Confirmatory factor analysis of posttraumatic stress symptoms in emergency personnel: An examination of seven alternative models. *Personality and Individual Differences*. 2006; 41:213–224. [10.1016/j.paid.2005.11.034](https://doi.org/10.1016/j.paid.2005.11.034)
- Anthony JL, Lonigan CJ, Hecht SA. Dimensionality of posttraumatic stress disorder symptoms in children exposed to disaster: Results from confirmatory factor analyses. *Journal of Abnormal Psychology*. 1999; 108:326–336. [PubMed: 10369043]
- Armour C, Shevlin M. Testing the dimensionality of PTSD and the specificity of the dysphoria factor. *Journal of Loss and Trauma*. 2010; 15:11–27.
- *. Asmundson GJG, Frombach I, McQuaid J, Pedrelli P, Lenox R, Stein MB. Dimensionality of posttraumatic stress symptoms: A confirmatory factor analysis of *DSM-IV* symptom clusters and

other symptom models. *Behavior Research and Therapy*. 2000; 38:203–214.10.1016/S0005-7967(99)00061-3

- Asmundson GJG, Wright KD, McCreary DR, Pedlar D. Post-traumatic stress disorder in United Nations peacekeepers: An examination of factor structure in peacekeepers with and without chronic pain. *Cognitive Behaviour Therapy*. 2003; 32:26–37. [PubMed: 16291532]
- *. Baschnagel JS, O'Connor RM, Colder CR, Hawk LW. Factor structure of posttraumatic stress among Western New York undergraduates following the September 11th terrorist attack on the World Trade Center. *Journal of Traumatic Stress*. 2005; 18:677–684.10.1002/jts.20076 [PubMed: 16382430]
- *. Beck JG, Coffey SF, Palyo SA, Gudmundsdottir B, Miller LM, Colder CR. Psychometric properties of the Posttraumatic Cognitions Inventory (PTCI): A replication with motor vehicle accident survivors. *Psychological Assessment*. 2004; 16:289–298.10.1037/1040-3590.16.3.289 [PubMed: 15456384]
- Blake DD, Weathers FW, Nagy LM, Kaloupek DG, Klauminzer G, Charney DS, Keane TM. A clinician rating scale for assessing current and lifetime PTSD: The CAPS-1. *Behavior Therapist*. 1990; 13:187–188.
- Boelen PA, van den Hout MA, van den Bout J. The factor structure of posttraumatic stress disorder symptoms among bereaved individuals: A confirmatory factor analysis study. *Journal of Anxiety Disorders*. 2008; 22:1377–1383.10.1016/j.janxdis.2008.01.018 [PubMed: 18342486]
- Brown TA, Chorpita BF, Barlow DH. Structural relationship among dimensions of the *DSM-IV* anxiety and mood disorders and dimensions of negative affect, positive affect, and autonomic arousal. *Journal of Abnormal Psychology*. 1998; 107:179–192.10.1037/0021-843X.107.2.179 [PubMed: 9604548]
- Bryant RA. Does dissociation further our understanding of PTSD? *Journal of Anxiety Disorders*. 2007; 21:183–191.10.1016/j.janxdis.2006.09.012 [PubMed: 17097264]
- Buckley TC, Blanchard EB, Hickling EJ. A confirmatory factor analysis of posttraumatic stress symptoms. *Behavior Research and Therapy*. 1998; 36:1091–1099.10.1016/S0005-7967(98)00076-X
- *. Carlson EB. Psychometric study of a brief screen for PTSD: Assessing the impact of multiple traumatic events. *Assessment*. 2001; 8:431–441.10.1177/107319110100800408 [PubMed: 11785587]
- Cheung MW, Chan W. Meta-analytic structural equation modeling: A two-stage approach. *Psychological Methods*. 2005; 10:40–64.10.1037/1082-989X.10.1.40 [PubMed: 15810868]
- Clark LA, Watson D. Tripartite model of anxiety and depression: Psychometric evidence and taxonomic implications. *Journal of Abnormal Psychology*. 1991; 100:316–336.10.1037/0021-843X.100.3.316 [PubMed: 1918611]
- *. Cook JM, Elhai JD, Arean PA. Psychometric properties of the PTSD checklist with older primary care patients. *Journal of Traumatic Stress*. 2005; 18:371–376.10.1002/jts.20038 [PubMed: 16281234]
- Cordova MJ, Studts JL, Hann DM, Jacobsen PB, Andrykowski MA. Symptom structure of PTSD following breast cancer. *Journal of Traumatic Stress*. 2000; 13:301–319.10.1023/A:1007762812848 [PubMed: 10838677]
- Cox BJ, Mota N, Clara I, Asmundson GJ. The symptom structure of posttraumatic stress disorder in the National Comorbidity Replication Survey. *Journal of Anxiety Disorders*. 2008; 22:1523–1528. [PubMed: 18440773]
- *. Creamer M, Bell R, Failla S. Psychometric properties of the Impact of Event Scale—Revised. *Behavior Research and Therapy*. 2003; 41:1489–1496.10.1016/j.brat.2003.07.010
- Cudeck R. Analysis of correlation matrices using covariance structure models. *Psychological Bulletin*. 1989; 105:317–327.10.1037/0033-2909.105.2.317
- Davidson JRT, Book SW, Colket JT, Tupler LA, Roth S, David D, et al. Feldman ME. Assessment of a new self-rating scale for posttraumatic stress disorder. *Psychological Medicine*. 1997; 27:153–160.10.1017/S0033291796004229 [PubMed: 9122295]

- *. Davis JL, Wright DC. Randomized clinical trial for treatment of chronic nightmares in trauma-exposed adults. *Journal of Traumatic Stress*. 2007; 20:123–133.10.1002/jts.20199 [PubMed: 17427914]
- *. DuHamel KN, Ostroff J, Ashman T, Winkel G, Mundy EA, Keane TM, et al. Redd W. Construct validity of the Posttraumatic Stress Disorder Checklist in cancer survivors: Analyses based on two samples. *Psychological Assessment*. 2004; 16:255–266.10.1037/1040-3590.16.3.255 [PubMed: 15456381]
- Elklit A, Shevlin M. The structure of PTSD symptoms: A test of alternative models using confirmatory factor analysis. *British Journal of Clinical Psychology*. 2007; 46:299–313.10.1348/014466506X171540 [PubMed: 17535523]
- Fabrigar LR, Wegener DT, MacCallum RC, Strahan EJ. Evaluating the use of exploratory factor analysis in psychological research. *Psychological Methods*. 1999; 4:272–299.10.1037/1082-989X.4.3.272
- Falsetti SA, Resnick HS, Resick PA, Kilpatrick D. The Modified PTSD Symptom Scale: A brief self-report measure of post-traumatic stress disorder. *Behavioral Therapist*. 1993; 16:161–162.
- Foa E, Cashman L, Jaycox L, Perry K. The validation of a self-report measure of PTSD: The Posttraumatic Diagnostic Scale. *Psychological Assessment*. 1997; 9:445–451.10.1037/1040-3590.9.4.445
- Foa E, Riggs D, Dancu C, Rothbaum B. Reliability and validity of a brief instrument for assessing posttraumatic stress disorder. *Journal of Traumatic Stress*. 1993; 6:459–473.10.1002/jts.2490060405
- *. Forbes D, Parslow R, Creamer M, Allen N, McHugh T, Hopwood M. Mechanisms of anger and treatment outcome in combat veterans with posttraumatic stress disorder. *Journal of Traumatic Stress*. 2008; 21:142–149.10.1002/jts.20315 [PubMed: 18404639]
- Gibbons RD, Bock RD, Hedeker D, Weiss DJ, Segawa E, Bhaumik DK, et al. Stover A. Full-information bi-factor analysis of graded response data. *Applied Psychological Measurement*. 2007; 31:4–19.10.1177/0146621606289485
- Gibbons RD, Hedeker D. Full-information item bi-factor analysis. *Psychometrika*. 1992; 57:423–436.10.1007/BF02295430
- Gorsuch, RL. *Factor analysis*. Hillsdale, NJ: Erlbaum; 1983.
- Gregorich SE. Do self-report instruments allow meaningful comparisons across diverse population groups? Testing measurement invariance using the confirmatory factor analysis framework. *Medical Care*. 2006; 44:S78–S94. [PubMed: 17060839]
- *. Griffin MG, Uhlmansiek MH, Resick PA, Mechanic MB. Comparison of the Posttraumatic Stress Disorder Scale versus the Clinician-Administered Posttraumatic Stress Disorder Scale in domestic violence. *Journal of Traumatic Stress*. 2004; 17:497–503.10.1007/s10960-004-5798-4 [PubMed: 15730068]
- *. Harper K, Stalker CA, Templeton G. The use and validity of the Canadian Occupational Performance Measure in a posttraumatic stress program. *Occupation, Participation, and Health*. 2006; 26:45–55.
- Holzinger KJ, Swineford F. The bi-factor method. *Psychometrika*. 1937; 2:41–54.10.1007/BF02287965
- *. Hoyt, T.; Yeater, EA. Factor structure of the PCL in a nonclinical undergraduate population Poster session presented at the annual meeting of the International Society for Traumatic Stress Studies. Baltimore, MD: Nov. 2007
- Hu L, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*. 1999; 6:1–55.10.1080/10705519909540118
- *. Jakupak M, Coneybeare D, Phelps L, Hunt S, Holmes HA, Felker B, et al. McFall ME. Anger, hostility, and aggression among Iraq and Afghanistan war veterans reporting PTSD and subthreshold PTSD. *Journal of Traumatic Stress*. 2007; 20:945–954.10.1002/jts.20258 [PubMed: 18157891]
- Jöreskog, K.; Sörbom, D. *Lisrel 8: Users reference guide*. Chicago, IL: Scientific Software International; 1996.

- Kashdan TB, Elhai JD, Frueh BC. Anhedonia and emotional numbing in combat veterans with PTSD. *Behavior Research and Therapy*. 2006; 44:457–467.10.1016/j.brat.2005.03.001
- *. Kimerling R, Ouimette P, Prins A, Nisco P, Lowler C, Cronkite R, Moos RH. Utility of a short screening scale for *DSM-IV* PTSD in primary care. *Journal of General Internal Medicine*. 2006; 21:65–67.10.1111/j.1525-1497.2005.00292.x [PubMed: 16423126]
- King DW, Leskin GA, King LA, Weathers FW. Confirmatory factor analysis of the Clinician-Administered PTSD Scale: Evidence of the dimensionality of posttraumatic stress disorder. *Psychological Assessment*. 1998; 10:90–96.10.1037/1040-3590.10.2.90
- King LA, King DW, Orazem MA, Palmieri PA. Research on the latest structure of PTSD. *PTSD Research Quarterly*. 2006; 17:1–8.
- *. Krause ED, Kaltman S, Goodman LA, Dutton MA. Longitudinal factor structure of posttraumatic stress symptoms related to intimate partner violence. *Psychological Assessment*. 2007; 19:165–175.10.1037/1040-3590.19.2.165 [PubMed: 17563198]
- Lancaster SL, Melka SE, Rodriguez BF. An examination of the differential effects of the experience of *DSM-IV* defined traumatic events and life stressors. *Journal of Anxiety Disorders*. 2009; 23:711–717.10.1016/j.janxdis.2009.02.010 [PubMed: 19307093]
- *. Lapierre CB, Schwegler AF, LaBauve BJ. Posttraumatic stress and depression symptoms in soldiers returning from combat operations in Iraq and Afghanistan. *Journal of Traumatic Stress*. 2007; 20:933–943.10.1002/jts.20278 [PubMed: 18157882]
- Litz BT, Orsillo SM, Kaloupek D, Weathers F. Emotional processing in posttraumatic stress disorder. *Journal of Abnormal Psychology*. 2000; 109:26–39.10.1037/0021-843X.109.1.26 [PubMed: 10740933]
- *. Lunney CA, Schnurr PP. Domains of quality of life and symptoms in male veterans treated for posttraumatic stress disorder. *Journal of Traumatic Stress*. 2007; 20:955–964.10.1002/jts.20269 [PubMed: 18157892]
- Marsh HW, Hocevar D. Application of confirmatory factor analysis to the study of self-concept: First- and higher order factor models and their invariance across groups. *Psychological Bulletin*. 1985; 97:562–582.10.1037/0033-2909.97.3.562
- *. Marshall GN. Posttraumatic Stress Disorder Symptom Checklist: Factor structure and English–Spanish measurement invariance. *Journal of Traumatic Stress*. 2004; 17:223–230.10.1023/B:JOTS.0000029265.56982.86 [PubMed: 15253094]
- *. McDevitt-Murphy ME, Weathers FW, Adkins JW, Daniels JB. Use of the Personality Assessment Inventory in assessment of posttraumatic stress disorder in women. *Journal of Psychopathology and Behavioral Assessment*. 2005; 27:57–65.10.1007/s10862-005-5380-2
- McDonald SD, Beckham JC, Morey R, Marx C, Tupler L, Calhoun PS. Factorial invariance of posttraumatic stress disorder symptoms across three veteran samples. *Journal of Traumatic Stress*. 2008; 21:309–317.10.1002/jts.20344 [PubMed: 18553409]
- *. McWilliams LA, Cox BJ, Asmundson GJ. Symptom structure of posttraumatic stress disorder in a nationally representative sample. *Journal of Anxiety Disorders*. 2005; 19:626–641.10.1016/j.janxdis.2004.06.003 [PubMed: 15927777]
- *. Messman-Moore TL, Brown AL. PTSD scores for sexual victimization among college women. 2002 Unpublished raw data.
- Milanak ME, Berenbaum H. The relationship between PTSD symptom factors and emotion. *Journal of Traumatic Stress*. 2009; 22:139–145.10.1002/jts.20401 [PubMed: 19319919]
- Mineka S, Watson D, Clark LA. Comorbidity of anxiety and unipolar mood disorders. *Annual Review of Psychology*. 1998; 49:377–412.10.1146/annurev.psych.49.1.377
- Mollica RF, Caspi-Yavin Y, Bollini P, Truong T, Tor S, Lavelle J. The Harvard Trauma Questionnaire: Validating a cross-cultural instrument for measuring torture, trauma, and posttraumatic stress disorder in Indochinese refugees. *Journal of Nervous and Mental Disease*. 1992; 180:111–116.10.1097/00005053-199202000-00008 [PubMed: 1737972]
- *. Mueser KT, Salyers MP, Rosenberg SD, Ford JD, Fox L, Carty P. Psychometric evaluation of trauma and posttraumatic stress disorder assessments in persons with severe mental illness. *Psychological Assessment*. 2001; 13:110–117.10.1037/1040-3590.13.1.110 [PubMed: 11281032]

- Norris FH, Perilla JL, Murphy AD. Post-disaster stress in the United States and Mexico: A cross-cultural test of the multicriterion conceptual model of posttraumatic stress disorder. *Journal of Abnormal Psychology*. 2001; 110:553–563.10.1037/0021-843X.110.4.553 [PubMed: 11727945]
- Olf M, Sijbrandij M, Opmeer BC, Carlier IV, Gersons BP. The structure of acute posttraumatic stress symptoms: “Reexperiencing,” “Active Avoidance,” “Dysphoria,” and “Hyperarousal. *Journal of Anxiety Disorders*. 2009; 23:656–659.10.1016/j.janxdis.2009.02.003 [PubMed: 19282141]
- *. Palmieri PA, Fitzgerald LF. Confirmatory factor analysis of posttraumatic stress symptoms in sexually harassed women. *Journal of Traumatic Stress*. 2005; 18:657–666.10.1002/jts.20074 [PubMed: 16382424]
- *. Palmieri PA, Marshall GN, Schell TL. Confirmatory factor analysis of posttraumatic stress symptoms in Cambodian refugees. *Journal of Traumatic Stress*. 2007; 20:207–216.10.1002/jts.20196 [PubMed: 17427910]
- Palmieri PA, Weathers F, Difede J, King D. Confirmatory factor analysis of the PTSD Checklist and the Clinician-Administered PTSD Scale in disaster workers exposed to the World Trade Center ground zero. *Journal of Abnormal Psychology*. 2007; 116:329–341.10.1037/0021-843X.116.2.329 [PubMed: 17516765]
- Pietrzak RH, Goldstein MB, Malley JC, Rivers AJ, Southwick SM. Structure of posttraumatic stress disorder symptoms and psychosocial functioning in veterans of Operations Enduring Freedom and Iraqi Freedom. *Psychiatry Research*. 2010; 178:323–329. [PubMed: 20546925]
- *. Pivac N, Kozaric-Kovacic D, Mustapic M, Dezeljin M, Borovecki A, Grubisic-Ilic M, Muck-Seler D. Platelet serotonin in combat related posttraumatic stress disorder with psychotic symptoms. *Journal of Affective Disorders*. 2006; 93:223–227.10.1016/j.jad.2006.02.018 [PubMed: 16647142]
- Prenoveau JM, Zinbarg RE, Craske MG, Mineka S, Griffith JW, Epstein AM. Testing a hierarchical model of anxiety and depression in adolescents: A tri-level model. *Journal of Anxiety Disorders*. 2010; 24:334–344.10.1016/j.janxdis.2010.01.006 [PubMed: 20171054]
- Raftery AE. Approximate Bayes factors and accounting for model uncertainty in generalized linear models. *Biometrika*. 1996; 83:251–266.10.1093/biomet/83.2.251
- Rigdon EE. CFI versus RMSEA: A comparison of two fit indexes for structural equation modeling. *Structural Equation Modeling*. 1996; 3:369–379.
- *. Rothbaum BO, Astin MC, Marsteller F. Prolonged exposure versus eye movement desensitization and reprocessing (EMDR) for PTSD rape victims. *Journal of Traumatic Stress*. 2005; 18:607–616.10.1002/jts.20069 [PubMed: 16382428]
- *. Ruggiero KJ, Ben KD, Scotti JR, Rabalais AE. Psychometric properties of the PTSD Checklist—Civilian Version. *Journal of Traumatic Stress*. 2003; 16:495–502.10.1023/A:1025714729117 [PubMed: 14584634]
- Schinka JA, Brown LM, Borenstein AR, Mortimer JA. Confirmatory factor analysis of the PTSD Checklist in the elderly. *Journal of Traumatic Stress*. 2007; 20:281–289. [PubMed: 17597125]
- *. Shelby RA, Golden-Kreutz DM, Andersen BL. Mismatch of PTSD symptoms and *DSM-IV* symptom clusters in a cancer sample: Exploratory factor analysis of the PTSD Checklist—Civilian Version. *Journal of Traumatic Stress*. 2005; 18:347–357.10.1002/jts.20033 [PubMed: 16281232]
- Shevlin M, McBride O, Armour C, Adamson G. Reconciling the differences between the King et al. (1998) and Simms et al. (2002) factor models of PTSD. *Journal of Anxiety Disorders*. 2009; 23:995–1001. [PubMed: 19632810]
- Simms LJ, Gros D, Watson D, O'Hara MW. Parsing the general and specific components of depression and anxiety with bifactor modeling. *Depression and Anxiety*. 2008; 25:E34–E46.10.1002/da.20432 [PubMed: 18027844]
- *. Simms LJ, Watson D, Doebbeling BN. Confirmatory factor analyses of posttraumatic stress symptoms in deployed and non-deployed veterans of the Gulf War. *Journal of Abnormal Psychology*. 2002; 111:637–647.10.1037/0021-843X.111.4.637 [PubMed: 12428777]
- *. Sullivan TP, Holt LJ. PTSD symptom clusters are differentially related to substance abuse among community women exposed to intimate partner violence. *Journal of Traumatic Stress*. 2008; 21:173–180.10.1002/jts.20318 [PubMed: 18404637]

- *. Taft CT, Vogt DS, Marshall AD, Panuzio J, Niles BL. Aggression among combat veterans: Relationships with combat exposure and symptoms of posttraumatic stress disorder, dysphoria, and anxiety. *Journal of Traumatic Stress*. 2007; 20:135–145.10.1002/jts.20197 [PubMed: 17427912]
- *. Taylor S, Kuch K, Koch WJ, Crockett DJ, Passey G. The structure of posttraumatic stress symptoms. *Journal of Abnormal Psychology*. 1998; 107:154–160.10.1037/0021-843X.107.1.154 [PubMed: 9505048]
- *. Vázquez C. Post-traumatic stress reactions following the March 11, 2004 terrorist attacks in a Madrid community sample: A cautionary note about the measurement of psychological trauma. *Spanish Journal of Psychology*. 2006; 9:61–74. [PubMed: 16673624]
- *. Vogt DS, Tanner LR. Risk and resilience factors for posttraumatic stress symptomatology in Gulf War 1 veterans. *Journal of Traumatic Stress*. 2007; 20:27–38.10.1002/jts.20187 [PubMed: 17345645]
- Watson D, Gamez W, Simms LJ. Basic dimensions of temperament and their relation to anxiety and depression: A symptom-based perspective. *Journal of Research in Personality*. 2005; 39:46–66.10.1016/j.jrp.2004.09.006
- Weathers, FW.; Litz, BT.; Herman, DS.; Huska, JA.; Keane, TM. The PTSD Checklist (PCL): Reliability, validity, and diagnostic utility; Paper presented at the annual meeting of the International Society of Traumatic Stress Studies; San Antonio, TX. 1993 Oct.
- *. Weathers FW, Ruscio AM, Keane TM. Psychometric properties of nine scoring rules for the Clinician-Administered Posttraumatic Stress Disorder Scale. *Psychological Assessment*. 1999; 11:124–133.10.1037/1040-3590.11.2.124
- *. Weaver TL, Resick HS, Kokoska MS, Etzel JC. Appearance-related residual injury, posttraumatic stress, and body image: Associations within a sample of female victims of intimate partner violence. *Journal of Traumatic Stress*. 2007; 20:999–1008.10.1002/jts.20274 [PubMed: 18157883]
- *. Winston FK, Kassam-Adams N, Garcia-Espana F, Ittenbach R, Cnaan A. Screening for risk of persistent posttraumatic stress in injured children and their parents. *JAMA*. 2003; 6:643–649. [PubMed: 12902368]
- *. Yufik T, Simms LJ. An investigation of Criterion A in posttraumatic stress disorder. 2010 Manuscript in preparation.
- Zinbarg R, Yovel I, Revelle W, McDonald R. Estimating generalizability to a universe of indicators that all have one attribute in common: A comparison of estimators for omega. *Applied Psychological Measurement*. 2006; 30:121–144.10.1177/0146621605278814

Figure 1. Factor loadings and correlations for Model 4a

Figure 2. Factor loadings and correlations for Model 4b

Table 1
Sample Characteristics of Studies Included in the Meta-Analysis

Study	Trauma type	N	Measure
Asmundson et al. (2000) ^a	Medical	349	PCL
Baschnagel, O'Connor, Colder, & Hawk (2005) ^b	Terrorism	528	PDS
Beck et al. (2004)	MVA	110	CAPS
Carlson (2001)	Psychiatric	136	SPTSS
Cook, Elhai, & Arean (2005)	Elderly	142	PCL
Creamer, Bell, & Failla (2003)	Veterans	154	PCL
Davis & Wright (2007)	MVA	47	MPSS-SR
DuHamel et al. (2004) ^a	Medical	236	PCL
Forbes et al. (2008)	Veterans	103	PCL
Griffin, Uhlmansiek, Resick, & Mechanic (2004)	IPV	138	CAPS
Harper, Stalker, & Templeton (2006)	Nonspecific	349	MPSS-SR
Hoyt & Yeater (2007) ^c	Nonspecific	429	PCL
Jakupak et al. (2007)	Veterans	117	PCL
Kimerling et al. (2006)	Medical	34	CAPS
Krause, Kaltman, Goodman, & Dutton (2007) ^b	IPV	405	PCL
Lapierre, Schwegler, & LaBauve (2007)	Veterans	2,275	SPTSS
Lunney & Schnurr (2007)	Veterans	319	CAPS
Marshall (2004) ^a	IPV	290	PCL
Marshall (2004) ^a	IPV	120	PCL
McDevitt-Murphy, Weathers, Adkins, & Daniels (2005)	Nonspecific	55	CAPS
Messman-Moore & Brown (2002) ^c	IPV	379	PSS
Messman-Moore & Brown (2002) ^c	IPV	81	PSS
Messman-Moore & Brown (2002) ^c	IPV	45	PSS
Mueser et al. (2001)	Psychiatric	30	CAPS
Palmieri & Fitzgerald (2005) ^a	IPV	1,218	PCL
Palmieri, Marshall, & Schell (2007) ^a	Terrorism	488	HTQ
Pivac et al. (2006)	Veterans	96	CAPS
Ruggiero, Ben, Scotti, & Rabalais (2003)	College	418	PCL
Shelby, Golden-Kreutz, & Andersen (2005)	Medical	148	PCL
Simms, Watson, & Doebbeling (2002) ^b	Veterans	3,695	PCL
Sullivan & Holt (2008)	IPV	212	PDS
Taft, Vogt, Marshall, Panuzio, & Niles (2007)	Veterans	242	CAPS
Taylor, Kuch, Koch, Crockett, & Passey (1998)	Veterans	419	PSS
Vazquez (2006)	MVA	103	SCID
Vogt & Tanner (2007)	Terrorism	500	PCL
Weaver, Resick, Kokoska, Etzel (2007)			
Sample 1	IPV	25	PDS

Study	Trauma type	<i>N</i>	Measure
Sample 2	IPV	31	PDS
Winston, Kassam-Adams, Garcia-Espana, Ittenbach, & Cnaan (2003)	Medical	269	PCL
Yufik & Simms (2010) ^c	Veterans	41	PCL
Yufik & Simms (2010) ^c	IPV	51	PCL

Note. CAPS = Clinician-Administered PTSD Scale; HTQ = Harvard Trauma Questionnaire; IPV = interpersonal violence; Medical = individuals who have been diagnosed with a medical condition (i.e., cancer); MPSS-SR = Modified PTSD Symptom Scale; MVA = motor vehicle accident; PCL = PTSD Checklist; PDS = PTSD Diagnostic Scale; PSS = PTSD Symptom Scale; PTSD = posttraumatic stress disorder; SCID = Structured Clinical Interview for *DSM-IV* Diagnosis; SPTSS = Screen for Posttraumatic Stress Symptoms.

^aIndicates a study that supported the D. W. King, Leskin, King, and Weathers al. (1998) model.

^bIndicates a study that supported the Simms et al. (2002) model.

^cIndicates an unpublished study.

Table 2

Item Mapping for All Tested Models

DSM-IV PTSD symptom	Model				
	1	2	3	4a	4b
B1. Intrusive thoughts of trauma	P	I, A	I	I	I
B2. Recurrent dreams of trauma	P	I, A	I	I	I
B3. Flashbacks	P	I, A	I	I	I
B4. Emotional reactivity to trauma cues	P	I, A	I	I	I
B5. Physiological reactivity to trauma cues	P	I, A	I	I	I
C1. Avoiding thoughts of trauma	P	I, A	A, N	A	A
C2. Avoiding reminders of trauma	P	I, A	A, N	A	A
C3. Inability to recall aspects of trauma	P	I, A	A, N	N	D
C4. Loss of interest	P	H, N	A, N	N	D
C5. Detachment	P	H, N	A, N	N	D
C6. Restricted affect	P	H, N	A, N	N	D
C7. Sense of foreshortened future	P	H, N	A, N	N	D
D1. Sleep disturbance	P	H, N	H	H	D
D2. Irritability	P	H, N	H	H	D
D3. Difficulty concentrating	P	H, N	H	H	D
D4. Hypervigilance	P	H, N	H	H	H
D5. Exaggerated startle response	P	H, N	H	H	H

Note. DSM-IV = *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; American Psychiatric Association, 1994); PTSD = posttraumatic stress disorder; P = general PTSD; I = Intrusions; A = Avoidance; N = Numbing; D = Dysphoria; H = Hyperarousal.

Table 3

Fit Indices for Stage 1 TSSEM Analysis

Sample	<i>n</i>	Number of studies	χ^2	<i>df</i>	SRMR	RMSEA	CFI	GFI
All samples	14,827	40	23,610	5,304	.15	.07	.83	.90
PCL-M	4,418	4	1,647	680	.10	.07	.91	.90
PCL-C	4,106	9	10,049	2,720	.09	.06	.92	.90
CAPS	1,024	8	4,042	952	.09	.09	.85	.95
IPV-NSA	2,762	8	7,995	952	.10	.09	.82	.80
IPV-SA	384	4	923	408	.072	.06	.90	.90
Vets-NGW	705	4	2,667	408	.08	.07	.80	.84
Vets-GW	7,160	6	2,805	680	.10	.09	.82	.89

Note. TSSEM = two-stage structural equation modeling; SRMR = standardized root-mean-square residual; RMSEA = root-mean-square error of approximation; CFI = comparative fit index; GFI = goodness-of-fit index; PTSD = posttraumatic stress disorder; PCL-C = PTSD Checklist Civilian Version; PCL-M = PTSD Checklist Military Version; CAPS = Clinician-Administered PTSD Scale; IPV-NSA = interpersonal violence without substance abuse; IPV-SA = interpersonal violence with substance abuse; Vets-NGW = non-Gulf War veterans; Vets-GW = veterans of the Gulf War.

Table 4
Stage 2 TSSEM Fit Indices for All Tested Models on Combined Data

Model	df	χ^2	SRMR	RMSEA	NFI	CFI	GFI	BIC
1	119	6,266	.120	.120	.82	.82	.84	6,592
2	118	4,580	.088	.088	.98	.98	.98	4,916
3	116	4,134	.083	.048	.98	.98	.99	4,489
4a	113	2,937	.057	.041	.99	.99	.99	3,321
4b	113	2,621	.050	.039	.99	.99	.99	3,005 ^a
4a higher order	103	3,625	.070	.045	.99	.99	.99	4,009
4b higher order	103	3,548	.068	.045	.99	.99	.99	3,932
4a bifactor	103	3,386	.061	.047	.99	.99	.99	3,770
4b bifactor	103	2,641	.053	.041	.99	.99	.99	3,025

Note. $N = 40$ studies and 14,827 participants. TSSEM = two-stage structural equation modeling; SRMR = standardized root-mean-square residual; RMSEA = root-mean-square error of approximation; NFI = Bentler-Bonnett normed fit index; CFI = comparative fit index; GFI = goodness-of-fit index; BIC = Bayesian information criterion.

^aLowest BIC value across all models.

Table 5

Fit Indices for Stage 2 TSSEM Subsample Analyses

Subsample	Model	<i>n</i>	Number of studies	χ^2	<i>df</i>	SRMR	RMSEA	CFI	GFI	BIC
Vets-GW	4a	7,160	6	488.5	113	.20	.065	.99	.98	843
	4b			481	113	.20	.064	.99	.98	836 ^a
Vets-NGW	4a	705	4	364.09	113	.15	.053	.99	.98	626
	4b			353.52	113	.15	.052	.99	.98	615 ^a
IPV-SA	4a	384	4	461.69	113	.13	.063	.97	.97	700
	4b			440.32	113	.12	.061	.97	.97	678 ^a
IPV-NSA	4a	2,762	8	491.29	113	.18	.065	.98	.98	807
	4b			490.80	113	.18	.064	.98	.98	806 ^a
CAPS	4a	1,024	8	725.46	113	.086	.054	.97	.98	1,002
	4b			668.69	113	.078	.051	.98	.98	
PCL-C	4a	4,106	9	1,380.94	113	.078	.049	.99	.99	1,714
	4b			1,301.37	113	.073	.047	.99	.99	1,634 ^a
PCL-M	4a	4,418	4	362.85	113	.14	.053	.99	.98	699
	4b			281.54	113	.11	.044	.99	.99	617 ^a

Note. TSSEM = two-stage structural equation modeling; SRMR = standardized root-mean-square residual; RMSEA = root-mean-square error of approximation; CFI = comparative fit index; GFI = goodness-of-fit index; BIC = Bayesian information criterion; Vets-GW = veterans of the Gulf War; Vets-NGW = non-Gulf War veterans; IPV-SA = interpersonal violence with substance abuse; IPV-NSA = interpersonal violence without substance abuse; PTSD = posttraumatic stress disorder; CAPS = Clinician-Administered PTSD Scale; PCL-C = PTSD Checklist Civilian Version; PCL-M = PTSD Checklist Military Version.

^aLower BIC values within each model comparison.