PTSD symptom dimensions and their relationship to functioning in World Trade Center responders

Camilo J. Ruggero [a,*], Roman Kotov [b], Jennifer L. Callahan [a], Jared N. Kilmer [a], Benjamin J. Luft [b], Evelyn J. Bromet [b]

[a] Department of Psychology, University of North Texas, 1155 Union Circle #311280, Denton, TX 76203, USA
[b] Department of Psychiatry and Behavioral Sciences, Stony Brook University, Stony Brook, NY, USA

ABSTRACT

Post-traumatic stress disorder (PTSD) symptoms are common among responders to the 9/11 attacks on the World Trade Center and can lead to impairment, yet it is unclear which symptom dimensions are responsible for poorer functioning. Moreover, how best to classify PTSD symptoms remains a topic of controversy. The present study tested competing models of PTSD dimensions and then assessed which were most strongly associated with social/occupational impairment, depression, and alcohol abuse. World Trade Center responders ($n=954$) enrolled in the Long Island site of the World Trade Center Health Program between 2005 and 2006 were administered standard self-report measures. Confirmatory factor analysis confirmed the superiority of four-factor models of PTSD over the *DSM-IV* three-factor model. In selecting between four-factor models, evidence was mixed, but some support emerged for a broad dysphoria dimension mapping closely onto depression and contributing strongly to functional impairment. This study confirmed in a new population the need to revise PTSD symptom classification to reflect four dimensions, but raises questions about how symptoms are categorized. Results suggest that targeted treatment of symptoms may provide the most benefit, and that treatment of dysphoria-related symptoms in disaster relief workers may have the most benefit for social and occupational functioning.

© 2013 Elsevier Ireland Ltd. All rights reserved.

1. Introduction

Responders to the 9/11 attacks on the World Trade Center were exposed to significant physical and emotional trauma during the rescue, recovery, and clean-up efforts (Landrigan et al., 2004; Neria et al., 2011). Surveys following the attacks document that a substantial proportion of responders, from 5.8% to more than 20%, report symptoms consistent with the diagnosis of post-traumatic stress disorder (PTSD) (Evans et al., 2006; Perrin et al., 2007; Jayasinghe et al., 2008; Stellman et al., 2008; Evans et al., 2009; Berninger et al., 2010a; Berninger et al., 2010b; Chiu et al., 2011; Cukor et al., 2011; Luft et al., 2012). Moreover, many World Trade Center responders show evidence of impairment in occupational (Evans et al., 2006; Evans et al., 2009; Berninger et al., 2010a; Berninger et al., 2010b) and social functioning, (Evans et al., 2006; Stellman et al., 2008; Evans et al., 2009; Berninger et al., 2010a; Berninger et al., 2010b) as well as higher rates of depression and substance abuse (Galea et al., 2002; Ahern and Galea, 2006; Stellman et al., 2008; Evans et al., 2009; Neria et al., 2011). These findings are

consistent with the broader PTSD literature showing that trauma exposure often leads to serious psychological, somatic, and/or behavioral changes (e.g., Roberts et al., 1982; Stein et al., 1997; Zatzick et al., 1997; Riggs et al., 1998; Breslau, 2001; Krakow et al., 2001; Kuhn et al., 2003; Breslau et al., 2004; Smith et al., 2005; Nemeroff et al., 2006; Schnurr et al., 2006; Kibler et al., 2009).

Although several studies documented an association between PTSD and severity of impairment, few studies have addressed which specific dimensions of PTSD predict worse functioning, and none that we are aware of has considered this issue in disaster responders. This question is important for theoretical reasons: it can shed light on the link between symptoms and functioning and validate the classification of PTSD symptoms (Elhai and Palmieri, 2011). It also has practical importance for treating individuals who assisted in the clean-up and recovery after 9/11, as well as for recovery workers involved in other disasters.

Studies that examined functional correlates of *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision* (*DSM-IV TR*; American Psychiatric Association, 2000) three-dimensional symptom clusters suggest that avoidance/numbing is more strongly associated with impaired functioning compared to hyperarousal and reexperiencing (Riggs et al., 1998; North et al., 1999; Samper et al., 2004; Miller et al., 2008; Rona et al., 2009),

although one study (Norman et al., 2007) found the opposite. Other studies that have looked at the avoidance and numbing dimensions separately find that numbing is most associated with lower life satisfaction and functioning (Palmieri and Fitzgerald, 2005; Lunney and Schnurr, 2007).

Most existing studies looking at how specific dimensions affect functioning have relied on the *DSM-IV* nosology. Mounting evidence, however, challenges the validity of this three-dimension model in favor of four dimensions (see Elhai and Palmieri, 2011 for a review) or even five dimensions (Elhai et al., 2011; Pietrzak et al., 2012). Yufik and Simms (2010) performed a meta-analysis of 40 studies looking at the factor structure of PTSD symptoms and found that four-factor models consistently outperformed the three-factor *DSM-IV* model in describing how symptoms cluster. The best established alternatives to *DSM-IV* are the King et al. (1998) model and Simms et al. (2002) model. Both of them contain reexperiencing and avoidance dimensions (see Table 1). However, King et al. splits the remaining items between a numbing dimension (C3–C7) and a hyperarousal dimension (D1–D5). In contrast, Simms et al. broadened the King model's numbing dimension (C3–C7) to include three additional items D1–D3 (i.e., sleep problems, irritability, and concentration problems) that were part of the hyperarousal dimension in the King et al. model. This new dimension was relabeled Dysphoria and was thought to reflect symptoms of dysphoria or general distress, as opposed to symptoms unique to PTSD. In creating this new factor, Simms et al. were guided by structural models (e.g., Mineka et al., 1998) that had long attempted to reconcile the high rates of overlap between depressive and anxiety disorders. These theories posited the existence of a nonspecific component shared by both types of disorders, namely a general distress component. Simms et al. argued that items D1–D3 are not particularly unique to hyperarousal, but that they (along with items C3–C7) more likely reflect the general, nonspecific distress component observed in structural models. It is noteworthy that the *DSM-5* (APA, 2013) PTSD criteria continues to place these three items within the hyperarousal dimension, consistent with the King et al. model but in contrast to the model suggested by Simms et al.

Evidence for the superiority of one four-factor model over another has been mixed. In confirmatory factor analysis (CFA) studies, both models fit generally similar. Results from Yufik and Simms (2010) meta-analysis suggest more support for their model. Moreover, longitudinal studies show the Simms et al. (2002) factor structure remains stable across time, an important piece of evidence to support their model (Baschnagel et al., 2005; Krause et al., 2007). Palmieri et al. (2007), however, suggest that the method of assessment matters, with more support for the King et al. model when clinician-administered measures are used rather than self-report instruments. Although such differences in CFA fit exist, the bulk of CFA research finds the differences in fit between these models to be modest.

The overwhelming majority of previous studies of this issue have relied on CFA alone. Although important, exclusive reliance on fit indices is not the optimal method of validating one model over the other; rather, evidence of convergent and discriminant validity is required and can provide decisive evidence for a model, even in cases where that model has a worse fit. A few previous studies have considered clinical correlates of the different dimensions, but findings have been mixed (Marshall et al., 2010; Miller et al., 2010; Palmieri et al., 2007). The present study attempts to look at not only the internal factor structure of PTSD, but the relationship of dimensions to external variables.

In particular, the present study uses data from World Trade Center responders to address two aims: the first is to use CFA to compare the relative merits of different PTSD models (i.e., *DSM-IV* three-factor model, Simms et al. four-factor model, and King et al. four-factor model). For comparison purposes, a single factor model will also be included given that symptoms tend to be highly correlated (Yufik and Simms, 2010) and given that this is the implicit model suggested when clinicians or researchers rely on only a single PTSD score to assess PTSD severity. We hypothesized that the Simms et al. model would show the best fit. The second aim is to determine which PTSD dimensions are most strongly associated with social and work functioning, as well as alcohol abuse and depression. We hypothesized that the dysphoria and numbing dimensions would show the closest links with depression. Given that previous results using the *DSM-IV* PTSD structure have implicated the avoidance/numbing dimension as most associated with impaired functioning, we hypothesized that dimensions consisting of those symptoms would be the most associated with worse functioning and alcohol abuse.

Table 1
Item mapping for confirmatory factor analysis models.

DSM-IV PTSD symptom	One-factor	*DSM-IV* three-factor	King et al. four-factor	Simms et al. four-factor
B1. Intrusive thoughts of trauma	P	R	R	R
B2. Recurrent dreams of trauma	P	R	R	R
B3. Flashbacks	P	R	R	R
B4. Emotional reactivity to trauma cues	P	R	R	R
B5. Physiological reactivity to trauma cues	P	R	R	R
C1. Avoiding thoughts of trauma	P	A/N	A	A
C2. Avoiding reminders of trauma	P	A/N	A	A
C3. Inability to recall aspects of trauma	P	A/N	N	D
C4. Loss of interest	P	A/N	N	D
C5. Detachment	P	A/N	N	D
C6. Restricted affect	P	A/N	N	D
C7. Sense of foreshortened future	P	A/N	N	D
D1. Sleep disturbance	P	H	H	D
D2. Irritability	P	H	H	D
D3. Difficulty concentrating	P	H	H	D
D4. Hypervigilance	P	H	H	H
D5. Exaggerated startle response	P	H	H	H

Note. Factors on which symptoms were loaded: P, general PTSD; R, reexperiencing; A, avoidance; N, emotional numbing; H, hyperarousal; D, dysphoria.

2. Method

2.1. Participants

Participants were 954 patients who had an initial examination at the Long Island site of the World Trade Center Health Program (Moline et al., 2008) between October, 2005 and September, 2006 and completed the PTSD symptom inventory described below. A total of 1,025 patients were seen at the clinic for the first time during that interval, but 71 (6.9%) were missing PTSD inventory and have been excluded. The World Trade Center Health Program was established in 2002 to provide medical monitoring and treatment for World Trade Center rescue and recovery workers. Care is provided at seven clinics in New York and New Jersey. Participants must have worked or volunteered as part of the rescue, recovery, restoration, or cleanup of the World Trade Center sites and not be participating in other federally-funded World Trade Center health programs (Herbert et al., 2006). Recruitment into the program involves extensive, ongoing outreach efforts (e.g., media articles, union meetings, mailings, and approximately 50,000 telemarketing calls in diverse languages). We note that this is a treatment-seeking sample, representing consecutive admissions to the Long Island clinic.

The sample was primarily male (89.9%, $n=858$), Caucasian (89.6%, $n=843$), married or partnered (77.3%, $n=692$), with children (77.4%, $n=678$), and had a mean age of 42.2 (S.D.$=8.2$) years at the time of assessment. The majority had at least some college education (71.4%, $n=641$) and worked in law enforcement (69.2%, $n=645$) at the time of 9/11. Among the sample as a whole, the mean total score on the PTSD symptom checklist (PCL) was 27.7 (S.D.$=12.7$); 4.1% endorsed 2 or more symptoms on the CAGE; and levels of depression were relatively low (PHQ-9 mean$=3.6$, S.D.$=4.9$). Disruptions in social and work functioning for the sample as a whole were also minimal, with average SDS social and work scores being 1.2 (S.D.$=2.2$) and 0.97 (S.D.$=1.9$), respectively, corresponding with "none" to "mild" impairment.

However, a subset of the sample had elevated scores on symptom and functioning measures. Specifically, 10.9% had scores greater than 44 on the PCL, a frequently used cutoff for identifying individuals with probable PTSD (Blanchard et al., 1996). These individuals had worse social functioning ($M=5.4$, S.D.$=2.7$) and work functioning ($M=4.4$, S.D.$=2.8$) on the SDS, corresponding to "moderate" impairment. Likewise, depression scores were higher in this group ($M=12.7$, S.D.$=6.1$) and more of them (12.5%) endorsed two or more CAGE symptoms.

2.2. Procedures

All responders presenting at the Long Island site of the World Trade Center Health Program for their first routine health evaluation completed a battery of self-report questionnaires, including the measures listed below. All procedures and measures were approved by the Institutional Review Board of Stony Brook University. Although responders are not mandated to participate in research, close to 95% give written consent to participate.

2.3. Measures

2.3.1. PTSD symptoms

The PTSD symptom checklist (PCL) (Blanchard et al., 1996) is a 17-item self-report measure of symptom severity. Items correspond to the PTSD symptoms listed in the DSM-IV. Participants are asked to indicate the extent to which they experienced each symptom during the past month on a 5-point Likert scale ranging from "not at all" to "extremely." The PCL is widely used to screen for PTSD and the total score demonstrates good convergent validity and internal consistency (Wilkins et al., 2011). Internal consistency for the PCL was high for the overall score ($\alpha=0.95$) and adequate for subscale scores (α's > 0.78).

2.3.2. Social and occupational functioning

The Sheehan disability scale (SDS) (Leon et al., 1997) and six supplemental items were included to assess social and work functioning. The SDS includes two self-report items that use a 10-point response scale ranging from "not at all" to "extremely" to inquire about the extent to which symptoms have disrupted the responder's social life and work in the past month, with higher scores being associated with worse functioning. Internal consistency (α) for the SDS was high (0.92). The six additional items measured the extent to which PTSD symptoms in particular affected social activities, sexual activities, relationships with family/friends, and ability to work in the past month. Responders rated these items on a 5-point Likert scale ranging from "not at all" to "extremely". In addition, participants were asked to indicate whether they had been laid off or unemployed since 9/11, and whether they had been disabled due to a World Trade Center-related health problem.

2.3.3. Depressive and alcohol symptoms

Depression was assessed with the patient health questionnaire (PHQ-9) (Spitzer et al., 1999; Kroenke et al., 2001), on which responders rated the frequency with which each of the nine cardinal symptoms of depression occurred in the past two weeks, from "0$=$not at all" to "3$=$nearly every day." The measure is reliable, has good convergent validity with diagnostic interviews, and is responsive to treatment effects (Lowe et al., 2004). The four-item CAGE (Ewing, 1984) was used to screen for alcohol abuse. Endorsement of two or more items is indicative of possible abuse. The measure has excellent reliability; it has good validity in psychiatric inpatient samples, but varied performance in other populations (Dhalla and Kopec, 2007). In the present sample, internal consistency was high for PHQ-9 ($\alpha=0.90$) and moderate to low for the CAGE ($\alpha=0.68$).

2.4. Statistical analyses

Initial analyses used confirmatory factor analysis (CFA) to examine the relative merits of four different models of PTSD (i.e, a model with only a single factor, DSM-IV three-factor model, the Simms et al. four-factor model, and the King et al. four-factor model). In comparing these models, we considered the following seven fit indices: the χ^2 goodness-of-fit statistic, the comparative fit index (CFI), the Tucker–Lewis index (TLI), the root-mean-square error of approximation (RMSEA), the Akaike information criterion (AIC), the Bayesian information criterion (BIC), and the

sample size-adjusted BIC (ABIC) (Hu and Bentler, 1998; Hu and Bentler, 1999; Marsh et al., 2004). Although there are no strict criteria for evaluating these fit indices, conventional guidelines suggest that TLI and CFI ≥ 0.90 indicate adequate fit and ≥ 0.95 indicate excellent fit; RMSEA ≤ 0.08 indicates adequate fit and ≤ 0.06 indicates excellent fit (Marsh et al., 2004). There are no absolute cutoffs on the AIC, BIC, and ABIC, but these indices can be used to compare models, with lower values representing better fit (Akaike, 1974; Burnham and Anderson, 2002).

Using well-fitting models from the CFA, structural equation modeling (SEM) analyses were next performed to determine which PTSD dimensions had unique links with each of the psychosocial functioning variables. In particular, four separate latent functioning variables were specified corresponding with social functioning (i.e., one indicator from SDS and three from supplemental items), work functioning (i.e., one indicator from SDS and two from supplemental items), depression (i.e., nine indicators from PHQ-9) and alcohol abuse (i.e., four indicators from CAGE), respectively. The relationships between PTSD dimensions and these four latent functioning variables were examined in separate SEM models. Although the four latent outcomes are related, we decided to analyze them separately since the focus of this study is on the relation of each outcome to PTSD dimensions, rather than on the relations among the outcomes. Furthermore, a joint model would risk misspecification of relations between the four outcomes. Analyses were carried out in Mplus version 7 (Muthen and Muthen, 2012). Missing data (3.8% of observations were missing) were handled using full-information maximum likelihood estimation (Schafer and Graham, 2002).

3. Results

CFA was first used to compare the four PTSD models. As seen in Table 2, the four-factor solutions showed acceptable fit to the data and were superior to the unidimensional model and the three-factor DSM-IV model. The two four-factor models had identical fit on three indices, but the King et al. model had better fit on the remaining ones. Differences were not so large as to definitively recommend one model over another based on CFA fit indices alone. As seen in Table 3, the correlations among the four factors were high (> 0.70) regardless of the model, which suggests neither model isolated unique dimensions.

It is important to note that the key difference between the two models involves items D1–D3 (i.e., the King et al. model places them with hyperarousal whereas the Simms et al. model places them with the numbing items and re-labels the dimension dysphoria). Given this key distinction, differences in how these three items load between the two models were inspected. They loaded more strongly onto the dysphoria dimension (i.e., standardized loadings were 0.91, 0.90, and 0.87) in the Simms et al. model than they did on the hyperarousal dimension (i.e., standardized loadings were 0.74, 0.83, 0.85) of the King et al. model, providing support for the hypothesis that these items may be more related to a nonspecific general distress factor than to hyperarousal. Nevertheless, given the small difference in fit and loadings, both models were retained and parallel analyses were subsequently performed for each one to determine which relates more clearly to functioning, as well as depression and alcohol abuse.

Analyses were next performed to determine which PTSD dimensions had unique associations with social functioning, work functioning, alcohol abuse and depression. A separate SEM was run for each outcome for both the Simms et al. and King et al. models, resulting in eight different estimated models. Table 4 reports the resulting fit indices. Across outcomes, the Simms et al. and King et al. model had similar fit indices, although when different, the King et al. model tended to show superior fit. Again, however, differences were modest.

Table 5 reports the standardized regression coefficients for each latent dependent variable (i.e., social functioning, occupational functioning, alcohol abuse and depression symptoms) regressed on the PTSD dimensions. Among the effects reported there, the Simms et al. dysphoria dimension loaded strongly and uniquely onto the latent depressive variable, whereas as the King et al. model splits its link to depressive symptoms between the numbing and hyperarousal dimensions. With respect to other effects,

Table 2
Confirmatory factor analysis (CFA) model fit indices.

CFA model	n	df	χ^2	SRMR	RMSEA	CFI	TLI	AIC	BIC
One-factor	954	121	3024.43	0.23	0.16	0.75	0.72	36371	36609
DSM-IV three-factor	954	116	1138.20	0.05	0.10	0.91	0.90	34495	34758
King et al. four-factor	954	113	886.85	0.04	0.09	0.93	0.92	34250	34527
Simms et al. four-factor	954	113	957.68	0.04	0.09	0.93	0.91	34321	34598

Table 3
Correlations among PTSD dimensions in the Simms et al. (above diagonal) and King et al. (below diagonal) models.

	1	2	3	4
(1) Re-experiencing	1	0.83	0.81	0.84
(2) Avoidance	0.84	1	0.79	0.75
(3) Dysphoria/numbing	0.84	0.79	1	0.90
(4) Hyperarousal	0.83	0.72	0.87	1

Note. Correlations from CFA models. All correlations significant at $p < 0.01$.

both models suggested avoidance is related to alcohol abuse, but the King et al. model suggested numbing is related to alcohol abuse to an even greater extent. The Simms et al. model showed that the dysphoria was uniquely associated with social and work functioning, whereas reexperiencing was significantly associated with less depression. The King et al. model showed that the numbing and hyperarousal dimensions were correlated with social and work functioning. Reexperiencing again was associated with less depression, but was also associated with better social functioning.

4. Discussion

The present study tested competing models of PTSD structure and evaluated the relation of PTSD dimensions to functioning and clinical symptoms. Results confirmed the superiority of four-factor models of PTSD symptoms over the one-factor model and the three-factor structure of *DSM-IV*. Inferior fit of the *DSM-IV* model has been consistently documented across studies and populations (Elhai and Palmieri, 2011; Yufik and Simms, 2010). Four-factor models differ from the three-factor *DSM-IV* model in that they separate the avoidance and numbing symptoms. There are conceptual reasons to believe avoidance is distinct from other symptoms: they represent behavioral reactions to trauma-related stimuli, whereas numbing symptoms reflect changes in emotion or cognition and are not explicitly linked to trauma. *DSM-5* has acknowledged this distinction and has recognized avoidance as its own dimension, separate from numbing (called "negative alterations in cognition and mood" in *DSM-5*). Results from the present study support this change in *DSM-5*.

However, the choice of four-factor models is less clear, and there remains debate over how these models, as well as *DSM-5*, classify numbing and hyperarousal symptoms. The two models differ only in their placement of three symptoms (i.e., sleep problems, irritability, concentration problems), with Simms et al. conceptualizing them as part of nonspecific dysphoria and King et al. treating them as part of hyperarousal (similar to the *DSM-5* approach). Reliance on fit indices alone, here and in other studies (Elhai and Palmieri, 2011; Yufik and Simms, 2010), does not provide clear support for one model over the other, making it important to consider other criteria, such as differences in factor loading values as well as external validation.

In this respect, results from the present study offer slightly more support for the Simms et al. model. First, the three critical items that serve to distinguish the two models loaded more highly

onto the dysphoria dimension of the Simms et al. model than they did on the hyperarousal dimension of the King et al. model. Second, the dysphoria dimension showed high convergence with depression in the Simms et al. model, hardly surprising on its face, but important since it provides convergent validation of the dimension. In contrast, the King et al. model split the variance shared with depression between its numbing and hyperarousal dimensions.

Although together these findings shed light on relative merits of the four-factor models, they also raise questions about the nature of the criteria being used to define PTSD. The high inter-correlation of dimensions in both models (> 0.70), as well as less than ideal fit, suggests that symptom criteria lack unidimensionality. This is consistent with at least one previous study (Shevlin et al., 2009) that found several symptoms cross-load across PTSD factors, something most CFA models preclude. It may be appropriate for future studies of this issue to use measures that were developed with the goal of unidimensional items, and an appreciation of the convergent and discriminant validity not simply of the measure as a whole, but also of the specific dimensions. For example, Watson et al., 2007, 2012 developed scales that target symptom dimensions unique to PTSD. Until such measures are further developed and implemented, SEM models of PTSD that rely on *DSM* criteria per se may struggle to reveal the optimal structure of PTSD symptoms.

Beyond comparison of the different PTSD structural models, the present report provides evidence of how PTSD dimensions affect related psychopathology and functioning. After adjusting for the other dimensions, only dysphoria was uniquely related to social and work functioning, as well as depression, in the Simms et al. model, while these outcomes were uniquely related to only the numbing and hyperarousal dimensions of the King et al. model. Avoidance was uniquely associated with alcohol abuse in both models, but was also associated with numbing in the King et al. model. Across models, re-experiencing did not lead to negative effects.

Such results have clinical implications for treating the tens of thousands of responders who perform disaster relief work in general and World Trade Center responders in particular. Given that treatments can have differential effects on PTSD symptoms (e.g., Taylor et al., 2003), the present findings underscore the importance of prioritizing treatment targets. Interventions, either medical or psychotherapeutic, that target depressive symptoms may have the most benefit with respect to helping patients better function at work and in their relationships. In contrast, responders suffering from alcohol problems may benefit most from treatments that target symptoms of avoidance. Of course, prospective studies are needed to confirm the relationships we reported. Present findings also underscore the importance of assessing and attending to specific dimensions of PTSD, rather than to focusing exclusively on overall severity of symptoms.

The findings should be interpreted in light of study limitations. The present investigation focused on only four models of PTSD, but others have been proposed (Elhai et al., 2011; Pietrzak et al., 2012). We chose the models that have been most widely studied and supported in the literature (Yufik and Simms, 2010), but others

Table 4
SEM fit indices for models predicting social/work functioning, depression and alcohol abuse.

	n	df	χ^2	SRMR	RMSEA	CFI	TLI	AIC	BIC
Social functioning									
King et al. four-factor	954	179	1274.45	0.04	0.08	0.93	0.92	42654	43009
Simms et al. four-factor	954	180	1340.30	0.04	0.08	0.93	0.91	42717	43067
Work functioning									
King et al. four-factor	954	160	1006.53	.04	.07	.94	.92	38468	38808
Simms et al. four-factor	954	160	1068.53	.03	.08	.93	.92	38529	38870
Alcohol abuse									
King et al. four-factor	954	179	99076	.04	.07	.93	.92	32775	33130
Simms et al. four-factor	954	179	1067.33	.04	.07	.93	.92	32851	33206
Depression									
King et al. four-factor	954	289	2390.84	.05	.09	.89	.87	45620	46048
Simms et al. four-factor	954	290	2453.53	.04	.09	.88	.87	45680	46103

Note. Table 5 contains the regression coefficients for these models.

Table 5
Structural regression coefficients for PTSD factors predicting functioning, depression and alcohol abuse.

	Social functioning β (SE)	Work functioning β (SE)	Alcohol abuse β (SE)	Depression β (SE)
King et al. four-factor model				
Reexperiencing	**−0.16(0.06)***	−0.15 (0.08)	−0.14 (0.13)	**−0.24 (0.06)****
Avoidance	0.02(0.06)	0.11 (0.07)	**0.23 (0.12)****	0.04 (0.05)
Numbing	**0.69(0.07)****	**0.48 (0.09)****	**0.46 (0.07)****	**0.60 (0.07)****
Hyperarousal	**0.34(0.08)****	**0.50 (0.10)****	−0.13 (0.16)	**0.51 (0.07)****
	$R^2=0.81$**	**$R^2=0.84$****	**$R^2=0.18$****	**$R^2=0.84$****
Simms et al. four-factor model				
Reexperiencing	−0.11 (0.07)	−0.10 (0.08)	−0.24 (0.14)	**−0.15 (0.06)****
Avoidance	0.00 (0.06)	0.07 (0.07)	**0.29 (0.12)****	0.06 (0.05)
Dysphoria	**0.99 (0.04)****	**0.98 (0.08)****	0.24 (0.14)	**0.99 (0.04)****
Hyperarousal	−0.04 (0.06)	−0.02 (0.08)	0.12 (0.14)	−0.01 (0.05)
	$R^2=0.81$**	**$R^2=0.86$****	**$R^2=0.16$****	**$R^2=0.84$****

Note. Higher scores indicate worse functioning or greater symptoms. Estimated standardized coefficients were fixed not to exceed 1 for all models.

may be important. Moreover, several symptoms in the *DSM-5* diagnosis of PTSD were not assessed, limiting our ability to compare the present models to the current diagnostic manual. A further potential limitation had to do with the level of symptom severity. The sample used in the present study consisted of participants who, to one degree or another, had direct exposure to the events of 9/11. Nevertheless, they had mostly low levels of PTSD symptoms, with less than 11% meeting the threshold for probable PTSD. The structure of PTSD symptoms may be substantially different in a more severe sample or in a different population. For example, previous studies have suggested that the nature of PTSD symptom structure may vary by the type of trauma (Shevlin and Elklit, 2012). Finally, the data were derived from cross-sectional, self-report information and from responders attending a single clinic. Clinical interviews would better detect PTSD symptoms and would provide for a more valid assessment of social and work functioning, and could date the onset of symptoms and changes in functioning more reliably. Future longitudinal studies using alternative assessment methods are critical, especially considering that differences in how PTSD is assessed may affect SEM model results (Palmieri et al., 2007).

Despite these limitations, the present work breaks new ground in using an empirically-derived model of PTSD to investigate clinical correlates of symptom clusters. The results confirm that a four-factor model of PTSD applies to disaster recovery workers, that items in the dysphoria dimension reflect depressive symptoms, and that a focus on PTSD symptom dimensions, not simply overall symptom severity, is important. The findings have special relevance to those treating World Trade Center rescue, recovery, and clean-up workers. For those World Trade Center responders abusing alcohol, a focus on helping to reduce avoidance may be beneficial. For most responders, however, treatments that alleviate depressive symptoms may be the most direct path toward improving their work and social functioning.

References

Ahern, J., Galea, S., 2006. Social context and depression after a disaster: the role of income inequality. Journal of Epidemiology and Community Health 60, 766–770.

Akaike, H., 1974. A new look at the statistical mode identification. IEEE Transactions on Automatic Control 19, 716–723.

American Psychiatric Association, 2000. Diagnostic and Statistical Manual of Mental Disorders, Revised 4th ed. Author, Washington, DC.

American Psychiatric Association, 2013. Diagnostic and Statistical Manual of Mental Disorders, 5th ed. Author, Washington, DC.

Baschnagel, J.S., O'Connor, R.M., Colder, C.R., Hawk Jr., L.W., 2005. 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 6, 677–684.

Berninger, A., Webber, M.P., Cohen, H.W., Gustave, J., Lee, R., Niles, J.K., Chiu, S., Zeig-Owens, R., Soo, J., Kelly, K., Prezant, D.J., 2010a. Trends of elevated PTSD risk in firefighters exposed to the World Trade Center disaster: 2001–2005. Public Health Reports 125, 556–566.

Berninger, A., Webber, M.P., Niles, J.K., Gustave, J., Lee, R., Cohen, H.W., Kelly, K., Corrigan, M., Prezant, D.J., 2010b. Longitudinal study of probable post-traumatic stress disorder in firefighters exposed to the World Trade Center disaster. American Journal of Industrial Medicine 53, 1177–1185.

Blanchard, E.B., Jones-Alexander, J., Buckley, T.C., Forneris, C.A., 1996. Psychometric properties of the PTSD Checklist (PCL). Behaviour Research and Therapy 34, 669–673.

Breslau, N., 2001. Outcomes of posttraumatic stress disorder. The Journal of Clinical Psychiatry 62 (Suppl. 17), 55–59.

Breslau, N., Lucia, V.C., Davis, G.C., 2004. Partial PTSD versus full PTSD: an empirical examination of associated impairment. Psychological Medicine 34, 1205–1214.

Burnham, K.P., Anderson, D.R., 2002. Model selection and multimodel inference: a practical information-theoretic approach, 2nd ed. Springer-Verlag, New York.

Chiu, S., Niles, J.K., Webber, M.P., Zeig-Owens, R., Gustave, J., Lee, R., Rizzotto, L., Cohen, H.W., Prezant, D.J., 2011. Evaluating risk factors and possible mediation effects in posttraumatic depression and posttraumatic stress disorder comorbidity. Public Health Reports 126, 201–209.

Cukor, J., Wyka, K., Jayasinghe, N., Weathers, F., Giosan, C., Leck, P., Roberts, J., Spielman, L., Crane, M., Difede, J., 2011. Prevalence and predictors of posttraumatic stress symptoms in utility workers deployed to the World Trade Center following the attacks of September 11, 2001. Depression and Anxiety 28, 210–217.

Dhalla, S., Kopec, J.A., 2007. The CAGE questionnaire for alcohol misuse: a review of reliability and validity studies. Clinical and Investigative Medicine 30, 33–41.

Elhai, J.D., Palmieri, P.A., 2011. The factor structure of posttraumatic stress disorder: aliterature update, critique of methodology, and agenda for future research. Journal of Anxiety Disorders 25, 849–854.

Elhai, J.D., Biehn, T.L., Armour, C., Klopper, J.J., Frueh, B.C., Palmieri, P.A., 2011. Evidence for a unique PTSD construct represented by PTSD's D1–D3 symptoms. Journal of Anxiety Disorders 25, 340–345.

Evans, S., Giosan, C., Patt, I., Spielman, L., Difede, J., 2006. Anger and its association to distress and social/occupational functioning in symptomatic disaster relief workers responding to the September 11, 2001, World Trade Center disaster. Journal of Traumatic Stress 19, 147–152.

Evans, S., Patt, I., Giosan, C., Spielman, L., Difede, J., 2009. Disability and posttraumatic stress disorder in disaster relief workers responding to September 11, 2001, World Trade Center disaster. Journal of Clinical Psychology 65, 684–694.

Ewing, J.A., 1984. Detecting alcoholism. The CAGE questionnaire. The Journal of the American Medical Association 252, 1905–1907.

Galea, S., Ahern, J., Resnick, H., Kilpatrick, D., Bucuvalas, M., Gold, J., Vlahov, D., 2002. Psychological sequelae of the September 11 terrorist attacks in New York City. The New England Journal of Medicine 346, 982–987.

Herbert, R., Moline, J., Skloot, G., Metzger, K., Baron, S., Luft, B., Markowitz, S., Udasin, I., Harrison, D., Stein, D., Todd, A., Enright, P., Stellman, J.M., Landrigan, P.J., Levin, S.M., 2006. The World Trade Center disaster and the health of workers: five-year assessment of a unique medical screening program. Environmental Health Perspectives 114, 1853–1858.

Hu, L., Bentler, P., 1999. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. Structural Equation Modeling 6, 1–55.

Hu, L., Bentler, P.M., 1998. Fit indices in covariance structure modeling: sensitivity to underparameterized model misspecification. Psychological Methods 3, 424–453.

Jayasinghe, N., Giosan, C., Evans, S., Spielman, L., Difede, J., 2008. Anger and posttraumatic stress disorder in disaster relief workers exposed to the September 11, 2001 World Trade Center disaster: one-year follow-up study. The Journal of Nervous and Mental Disease 196, 844–846.

Kibler, J.L., Joshi, K., Ma, M., 2009. Hypertension in relation to posttraumatic stress disorder and depression in the US National Comorbidity Survey. Behavioral Medicine 34, 125–132.

King, D.W., Leskin, G.A., King, L.A., Weathers, F.W., 1998. Confirmatory factor analysis of the clinician-administered PTSD scale: evidence for the dimensionality of posttraumatic stress disorder. Psychological Assessment 10, 90–96.

Krakow, B., Melendrez, D., Pedersen, B., Johnston, L., Hollifield, M., Germain, A., Koss, M., Warner, T.D., Schrader, R., 2001. Complex insomnia: insomnia and sleep disordered breathing in a consecutive series of crime victims with nightmares and PTSD. Biological Psychiatry 49, 948–953.

Krause, E.D., Kaltman, S., Goodman, L.A., Dutton, M.A., 2007. Longitudinal factor structure of posttraumatic stress symptoms related to intimate partner violence. Psychological Assessment 19, 165–175.

Kroenke, K., Spitzer, R.L., Williams, J.B., 2001. The PHQ-9: validity of a brief depression severity measure. Journal of General Internal Medicine 16, 606–613.

Kuhn, E., Blanchard, E.B., Hickling, E.J., 2003. Posttraumatic stress disorder and psychosocial functioning within two samples of MVA survivors. Behaviour Research and Therapy 41, 1105–1112.

Landrigan, P.J., Lioy, P.J., Thurston, G., Berkowitz, G., Chen, L.C., Chillrud, S.N., Gavett, S.H., Georgopoulos, P.G., Geyh, A.S., Levin, S., Perera, F., Rappaport, S.M., Small, C., 2004. Health and environmental consequences of the world trade center disaster. Environmental Health Perspectives 112, 731–739.

Leon, A.C., Olfson, M., Portera, L., Farber, L., Sheehan, D.V., 1997. Assessing psychiatric impairment in primary care with the Sheehan disability scale. International Journal of Psychiatry in Medicine 27, 93–105.

Lowe, B., Unutzer, J., Callahan, C.M., Perkins, A.J., Kroenke, K., 2004. Monitoring depression treatment outcomes with the patient health questionnaire-9. Medical Care 42, 1194–1201.

Luft, B.J., Schechter, C., Kotov, R., Broihier, J., Reissman, D., Guerrera, K., Udasin, I., Moline, J., Harrison, D., Friedman-Jimenez, G., Pietrzak, R.H., Southwick, S.M., Bromet, E.J., 2012. Exposure, probable PTSD and lower respiratory illness among World Trade Center rescue, recovery and clean-up workers. Psychological Medicine 42, 1069–1079.

Lunney, C.A., Schnurr, P.P., 2007. Domains of quality of life and symptoms in male veterans treated for posttraumatic stress disorder. Journal of Traumatic Stress 20, 955–964.

Marsh, H., Hau, K., Wen, Z., 2004. In search of golden rules: comment on hypothesis testing approaches to setting cutoff values for fit indexes and dangers in overgeneralizing Hu and Bentler's (1999) findings. Structural Equation Modeling 11, 320–341.

Marshall, G.N., Schell, T.L., Miles, J.N.V., 2010. All PTSD symptoms are highly associated with general distress: ramifications for the dysphoria symptom cluster. Journal of Abnormal Psychology 119, 126–135.

Miller, M.W., Wolf, E.J., Harrington, K.M., Brown, T.A., Kaloupek, D.G., Keane, T.M., 2010. An evaluation of competing models for the structure of PTSD symptoms using external measures of comorbidity. Journal of Traumatic Stress 23, 631–638.

Miller, M.W., Wolf, E.J., Martin, E., Kaloupek, D.G., Keane, T.M., 2008. Structural equation modeling of associations among combat exposure, PTSD symptom factors, and global assessment of functioning. Journal of Rehabilitation Research and Development 45, 359–369.

Mineka, S., Watson, D., Clark, L.A., 1998. Comorbidity of anxiety and unipolar mood disorders. Annual Review of Psychology 49, 377–412.

Moline, J.M., Herbert, R., Levin, S., Stein, D., Luft, B.J., Udasin, I.G., Landrigan, P.J., 2008. WTC medical monitoring and treatment program: comprehensive health care response in aftermath of disaster. The Mount Sinai Journal of Medicine 75, 67–75.

Muthen, L.K., Muthen, B.O., 2012. Mplus. Statistical Analyses with Latent Variables. User's Guide, 7th ed. Muthen and Muthen, Los Angeles.

Nemeroff, C.B., Bremner, J.D., Foa, E.B., Mayberg, H.S., North, C.S., Stein, M.B., 2006. Posttraumatic stress disorder: a state-of-the-science review. Journal of Psychiatric Research 40, 1–21.

Neria, Y., DiGrande, L., Adams, B.G., 2011. Posttraumatic stress disorder following the September 11, 2001, terrorist attacks: a review of the literature among highly exposed populations. The American Psychologist 66, 429–446.

Norman, S.B., Tate, S.R., Anderson, K.G., Brown, S.A., 2007. Do trauma history and PTSD symptoms influence addiction relapse context? Drug and Alcohol Dependence 90, 89–96.

North, C.S., Nixon, S.J., Shariat, S., Mallonee, S., McMillen, J.C., Spitznagel, E.L., Smith, E.M., 1999. Psychiatric disorders among survivors of the Oklahoma city bombing. The Journal of the American Medical Association 282, 755–762.

Palmieri, P.A., Fitzgerald, L.F., 2005. Confirmatory factor analysis of posttraumatic stress symptoms in sexually harassed women. Journal of Traumatic Stress 18, 657–666.

Palmieri, P.A., Weathers, F.W., Difede, J., King, D.W., 2007. 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 116, 329–341.

Perrin, M.A., DiGrande, L., Wheeler, K., Thorpe, L., Farfel, M., Brackbill, R., 2007. Differences in PTSD prevalence and associated risk factors among World Trade Center disaster rescue and recovery workers. The American Journal of Psychiatry 164, 1385–1394.

Pietrzak, R.H., Tsai, J., Harpaz-Rotem, I., Whealin, J.M., Southwick, S.M., 2012. Support for a novel five-factor model of posttraumatic stress symptoms in three independent samples of Iraq/Afghanistan veterans: a confirmatory factor analytic study. Journal of Psychiatric Research 46, 317–322.

Riggs, D.S., Byrne, C.A., Weathers, F.W., Litz, B.T., 1998. The quality of the intimate relationships of male Vietnam veterans: problems associated with posttraumatic stress disorder. Journal of Traumatic Stress 11, 87–101.

Roberts, W.R., Penk, W.E., Gearing, M.L., Robinowitz, R., Dolan, M.P., Patterson, E.T., 1982. Interpersonal problems of Vietnam combat veterans with symptoms of posttraumatic stress disorder. Journal of Abnormal Psychology 91, 444–450.

Rona, R.J., Jones, M., Iversen, A., Hull, L., Greenberg, N., Fear, N.T., Hotopf, M., Wessely, S., 2009. The impact of posttraumatic stress disorder on impairment in the UK military at the time of the Iraq war. Journal of Psychiatric Research 43, 649–655.

Samper, R.E., Taft, C.T., King, D.W., King, L.A., 2004. Posttraumatic stress disorder symptoms and parenting satisfaction among a national sample of male Vietnam veterans. Journal of Traumatic Stress 17, 311–315.

Schafer, J.L., Graham, J.W., 2002. Missing data: our view of the state of the art. Psychological Methods 7, 147–177.

Schnurr, P.P., Hayes, A.F., Lunney, C.A., McFall, M., Uddo, M., 2006. Longitudinal analysis of the relationship between symptoms and quality of life in veterans treated for posttraumatic stress disorder. Journal of Consulting and Clinical Psychology 74, 707–713.

Shevlin, M., Elklit, A., 2012. The latent structure of posttraumatic stress disorder: different models or different populations? Journal of Abnormal Psychology 121, 610–615.

Shevlin, M., McBride, O., Armour, C., Adamson, G., 2009. Reconciling the differences between the King et al. (1998) and Simms et al. (2002) factor models of PTSD. Journal of Anxiety Disorders 23, 995–1001.

Simms, L.J., Watson, D., Doebbeling, B.N., 2002. Confirmatory factor analyses of posttraumatic stress symptoms in deployed and nondeployed veterans of the Gulf War. Journal of Abnormal Psychology 111, 637–647.

Smith, M.W., Schnurr, P.P., Rosenheck, R.A., 2005. Employment outcomes and PTSD symptom severity. Mental Health Services Research 7, 89–101.

Spitzer, R.L., Kroenke, K., Williams, J.B., 1999. Validation and utility of a self-report version of PRIME-MD: the PHQ primary care study. primary care evaluation of mental disorders. Patient health questionnaire. The Journal of the American Medical Association 282, 1737–1744.

Stein, M.B., Walker, J.R., Hazen, A.L., Forde, D.R., 1997. Full and partial posttraumatic stress disorder: findings from a community survey. The American Journal of Psychiatry 154, 1114–1119.

Stellman, J.M., Smith, R.P., Katz, C.L., Sharma, V., Charney, D.S., Herbert, R., Moline, J., Luft, J.J., Markowitz, S., Udasin, I., Harrison, D., Baron, S., Landrigan, P.J., Levin, S. M., Southwick, C., 2008. Enduring mental health morbidity and social function impairment in world trade center rescue, recovery, and cleanup workers: the psychological dimension of an environmental health disaster. Environmental Health Perspectives 116, 1248–1253.

Taylor, S., Thordarson, D.S., Maxfield, L., Fedoroff, I.C., Lovell, K., Ogrodniczuk, J., 2003. Comparative efficacy, speed, and adverse effects of three PTSD treatments: exposure therapy, EMDR, and relaxation training. Journal of Consulting and Clinical Psychology 71, 330–338.

Watson, D., O'Hara, M.W., Simms, L.J., Kotov, R., Chmielewski, M., McDade-Montez, E.A., Gamez, W., Stuart, S., 2007. Development and validation of the Inventory of Depression and Anxiety Symptoms (IDAS). Psychological Assessment 19, 253–268.

Watson, D., O'Hara, M.W., Naragon-Gainey, K., Koffel, E., Chmielewski, M., Kotov, R., Stasik, S.M., Ruggero, C.J., 2012. Development and validation of new anxiety and bipolar symptom scales for an expanded version of the IDAS (IDAS-II). Assessment 19, 399–420.

Wilkins, K.C., Lang, A.J., Norman, S.B., 2011. Synthesis of the psychometric properties of the PTSD checklist (PCL) military, civilian, and specific versions. Depression and Anxiety 28, 596–606.

Yufik, T., Simms, L.J., 2010. A meta-analytic investigation of the structure of posttraumatic stress disorder symptoms. Journal of Abnormal Psychology 119, 764–776.

Zatzick, D.F., Marmar, C.R., Weiss, D.S., Browner, W.S., Metzler, T.J., Golding, J.M., Stewart, A., Schlenger, W.E., Wells, K.B., 1997. Posttraumatic stress disorder and functioning and quality of life outcomes in a nationally representative sample of male Vietnam veterans. The American Journal of Psychiatry 154, 1690–1695.