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A confirmatory factor analysis of posttraumatic stress symptoms

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Abstract

Investigators have recently identified a two-factor structure underlying posttraumatic stress symptoms through the use of exploratory factor analysis [Taylor et al. (1998). The structure of posttraumatic stress symptoms. *Journal of Abnormal Psychology*, 107, 154–160]. These two factors, which were labeled as Intrusion and Avoidance, and Hyperarousal and Numbing, are consistent with current theoretical models of posttraumatic stress disorder – PTSD [e.g. Foa et al. (1992). Uncontrollability and unpredictability in post-traumatic stress disorder: An animal model. *Psychological Bulletin*, 112, 218–238]. However, the authors of the Taylor et al. study issued caution in interpreting their findings because there has yet to be a systematic replication of their results. This paper presents a confirmatory factor analysis of the two-factor structure of posttraumatic stress symptoms in 217 survivors of serious motor vehicle accidents with varying degrees of PTSD symptoms. A hierarchical, confirmatory-factor analysis conducted with a structural equation modeling statistics package confirmed that the model proposed by Taylor et al. can adequately account for the presentation of PTSD symptoms in this sample of motor vehicle accident survivors. The implications for the assessment and diagnosis of PTSD are discussed.

Keywords: Posttraumatic-stress-symptoms; Confirmatory-factor-analysis

1. Introduction

Since its introduction to the major diagnostic system with the publication of DSM-III (American Psychiatric Association, 1980), the diagnostic criteria for PTSD has been based on symptom clusters. With the publication of DSM-IIIR and DSM-IV (American Psychiatric

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Association, 1987, 1994) the number of symptoms included in the diagnostic criteria for PTSD increased. However, diagnosis by virtue of multiple symptom clusters has remained the same. Specifically, the diagnosis of PTSD is made only if a traumatized individual exhibits symptoms from a variety of symptom clusters which include: at least one re-experiencing symptom, at least three avoidance and numbing symptoms, and at least two hyperarousal symptoms.

To date, the clustering of these symptoms has been based on expert consensus rather than empirical criteria. Indeed, the diagnostic criteria have been criticized on many grounds. First, as is evident from the criteria, it is possible for a traumatized individual to be very symptomatic and still fall below the diagnostic threshold for diagnosis based on the cluster criteria. Research demonstrates that both the number and severity of PTSD symptoms are linearly associated with impairment on both psychopathology and major role functioning variables (Blanchard et al., 1994; Kulka et al., 1990). Recent work also suggests that those who are symptomatic, yet fall just below the threshold of cluster diagnosis, show more impairment on psychopathology and major role functioning variables following trauma than those who are well below the cluster threshold (Buckley et al., 1996). Thus, it may be the case that PTSD is more appropriately viewed as a dimensional syndrome rather than a syndrome defined by multiple symptom clusters.

The second criticism of these symptom clusters comes from a psychometric point of view. To date, 11 studies have factor analyzed the symptom structure of posttraumatic stress symptoms in traumatized individuals. Firm empirical support for the three symptom clusters has not emerged from this literature. However, drawing firm conclusions from these studies is difficult at this time for a number of reasons. As pointed out by Taylor et al. (1998), seven of the studies pre-dated the publication of DSM-IIIR and DSM-IV (e.g. Keane et al., 1988; Silver and Iacono, 1984). Thus, these seven studies factor analyzed item pools that were incomplete representations of the current diagnostic criteria. Moreover, the item pools in these studies were heterogeneous in nature.

Of the four studies which have factor analyzed the symptoms that make up the current diagnostic criteria for PTSD, none have supported the notion of the three distinct symptom clusters proposed by the DSM diagnostic system. The results of these studies vary as a function of trauma type. One study, which factor analyzed the symptom structure of Vietnam Veterans, found evidence for four factors (Keane, 1993); while studies with civilian trauma patients have found evidence for three factors other than those proposed by the DSM nosology (Foa et al., 1995; King et al., 1995). Taylor et al. (1998) criticized these latter studies on the grounds that their sample size was too small and/or their methods of data analysis were not such that stable factor structures could be identified. Moreover, these studies have utilized exploratory factor analytic methods. Thus, to some extent, each of these previous studies capitalized on sample-specific variance to account for the empirically derived factor structures.

Taylor et al. (1998) attempted to overcome some of these limitations by factor analyzing the symptom structure of two different trauma groups within the same study; one as a derivation sample and the other as a validation sample. They factor analyzed the posttraumatic stress symptoms of 103 motor vehicle accident survivors and 419 United Nations peacekeepers exposed to wartime atrocities in Bosnia. To date, it is the most methodologically sound factor analytic examination of posttraumatic stress symptoms. The authors found evidence of two factors that could account for symptom presentation. The first factor was labeled Intrusion

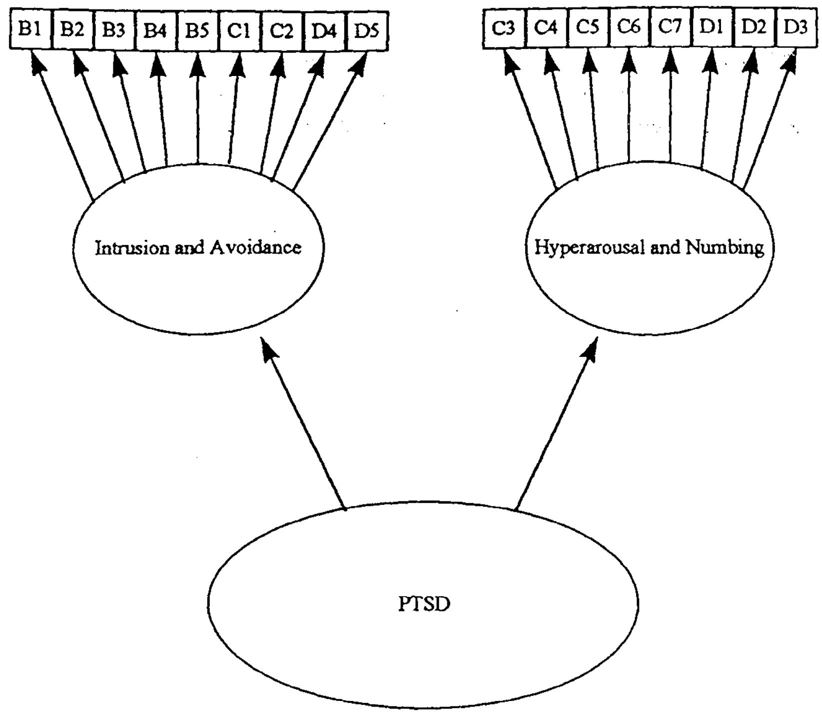

Fig. 1. Hierarchical two-factor model of posttraumatic stress symptoms. Individual PTSD symptoms are indicated by cluster letter and number within cluster.

and Avoidance and included all the items from cluster B as well as the cognitive and behavioral avoidance items from cluster C from the DSM-IV diagnostic criteria for PTSD. The second factor was labeled as Hyperarousal and Numbing and included the remainder of the cluster C symptoms (numbing) and most of the cluster D hyperarousal symptoms. This two factor structure held up equally well across both trauma groups. Underlying their two factors was a single higher-order factor, onto which, both the Intrusion and Avoidance and Hyperarousal and Numbing factors loaded. A graphic representation of this hierarchical factor structure can be found in Fig. 1. The circles represent the latent factor structures and the squared circles are the specific DSM-IV symptoms of PTSD indicated by cluster and item number within cluster.

This two factor model maps onto the theoretical model of PTSD proposed by Foa et al. (1992) which asserts that intrusive recollections of the trauma result in avoidance symptoms. The model also proposes that chronic hyperarousal symptoms give rise to numbing symptoms. Thus, the two factor solution proposed by Taylor et al. (1998) is parsimonious on both theoretical and statistical grounds. However, Taylor et al. issued appropriate caution about over interpreting their results. They suggested that their results were in need of systematic replication. We agree with this cautionary statement as past studies, which have attempted to derive symptom clusters by empirical analysis, have mostly relied on exploratory methods that capitalized on sample specific variability to define the clusters. Systematic replication of factor structures across laboratories and trauma types has not occurred.

This current paper presents a confirmatory factor analysis of the two-factor model of posttraumatic stress symptoms derived by Taylor et al. (1998) in 217 survivors of serious motor vehicle accidents. A structural equation modeling package (LISREL 8.14a, Jöreskog and Sörbom, 1993) was used to conduct a higher-order factor analysis of the two factor model proposed in Fig. 1.

2. Method

2.1. Participants

Sample 1 consisted of 158 survivors of serious motor vehicle accidents (MVAs) who were evaluated 1–4 months post-MVA as part of a longitudinal study that examined the psychosocial consequences of being a MVA survivor (a complete account of that study can be found in Blanchard and Hickling, 1997). Sample 2 consisted of 59 survivors of serious MVAs who were assessed as part of an ongoing randomized-controlled clinical trial evaluating the efficacy of cognitive/behavioral treatment, for the treatment of MVA-related PTSD. Since the same assessment instrument was used in both studies to assess for the presence/absence of PTSD symptoms (see measures), the data from the two samples were combined in order to provide a more stable estimate of the factor structures. The demographic characteristics, psychopathology measures, and diagnostic status of the two samples can be found in Table 1.

2.2. Measures

Presence or absence of PTSD symptoms was confirmed through the use of the Clinician Administered PTSD Scale (CAPS); a semi-structured interview with good validity and reliability for arriving at a diagnosis of PTSD (Blake et al., 1997). On the CAPS, each of the seventeen symptoms associated with the diagnostic criteria for PTSD is given both a frequency

Table 1
Demographic characteristics of sub-samples

Variable	Sample 1 (n = 158)	Sample 2 (n = 59)
Age (yr)	35.4 (12.5)	37.5 (12.1)
Gender (% male/female)	31.6/68.4	27.1/72.9
Ethnicity (% white/minority)	88.6/11.4	89.8/10.2
% PTSD	39	68
Mean CAPS score	34.9 (26.2)	58.2 (29.8)

PTSD = posttraumatic stress disorder.
CAPS = clinician administered PTSD scale.

and an intensity score ranging from 0–4. Higher numbers indicate more frequent or more intense symptoms. Thus, for each symptom, a summation score ranging from 0–8 is generated, with higher numbers indicating greater severity.

In sample one, the CAPS was conducted by one of four doctoral level psychologists with at least five years experience in the assessment and treatment of PTSD populations. All were trained by a doctoral level psychologist who was involved in the construction of the CAPS interview. In sample two, the CAPS was conducted by a doctoral level psychologist or advanced doctoral students in clinical psychology who were trained by an experienced assessor.

2.3. Data Analysis

The hierarchical factor structure in Fig. 1 was subjected to a confirmatory factor analysis with a structural equation statistics package (LISREL 8.14a, Jöreskog and Sörbom, 1993). The individual item scores for each of the seventeen symptoms of PTSD, as measured by the CAPS 0–8 scale, were used as observed indicators of two subordinate latent constructs of Intrusion and Avoidance and Hyperarousal and Numbing.

In attempting to confirm the factor structure derived by Taylor et al. (1998) we forced the following CAPS items onto the Intrusion and Avoidance factor: intrusive recollections, dreams, distress upon exposure to trauma reminiscent cues, flashbacks, physiological arousal upon exposure to trauma reminiscent cues, cognitive avoidance, behavioral avoidance, increased startle response, and hypervigilance. The remaining CAPS items were forced onto the Hyperarousal and Numbing factor: sleep difficulties, irritability/anger, difficulties with concentration, restricted range of affect, emotional numbing, sense of foreshortened future, anhedonia, detachment, and inability to recall aspects of the trauma. We estimated the path (correlation) between the two latent constructs in order to determine the extent to which a common, higher-order factor could account for the relation between the two subordinate factors.

2.4. Fit indices

LISREL output generates 'fit indices' which allow researchers to estimate the goodness of fit for the proposed models under evaluation. There are three general classes of fit indices, the first of which examines absolute degree of fit, i.e. how well did the observed pattern of correlations match the predicted pattern of correlations. The second and third classes of fit indices examine the parsimony of the model and the relative model fit respectively. Parsimony-of-fit indices evaluate model fit after taking into account the number of paths estimated in the model. A greater the number of paths estimated will always yield better model fit, thus, these statistics provide a fit index after adjusting for the number of paths assessed in the model. Relative-model-fit indices compare how well the proposed model can account for the data as opposed to alternative models (usually a 'null' model which assumes no correlation among the variables). Since each class of statistics is influenced by different aspects of the data and each class conveys unique information about model fit, it is generally accepted that assessing the adequacy of tested models is best accomplished by examining fit indices from all three classes (Bentler, 1990). We utilized the following fit indices to examine model fit: the Chi square statistic, the standardized root mean square (standardized RMR), goodness of fit index (GFI), root mean square error of approximation (RMSEA), and the comparative fit index (CFI).

3. Results

Examining the absolute fit indices, we find that the Chi square statistic was significant ($\chi^2 = 271.19$ (118), $p < 0.01$). This indicates that the difference between the observed and predicted variance–covariance matrix is 'statistically significant'. Conventional interpretation of a significant χ^2 is one of poor model fit. However, the χ^2 statistic is sensitive enough to detect trivial differences between the observed and predicted variance–covariance matrix at large sample sizes. The standardized root mean square (standardized RMR), which is another absolute fit index, gives one a sense of the magnitude of the difference between the two matrices. The standardized RMR was 0.057, which is indicative of good model fit. The standardized RMR is interpreted as the average absolute discrepancy between the predicted and observed correlations. Thus, the overall absolute fit of the model is good, as judged by the Standardized RMR. This suggests that the 'statistically significant difference' between the observed and predicted variance–covariance matrices (as judged by χ^2) was a function of the large N rather than ill model fit. The goodness of fit index (GFI) was 0.87, indicating reasonable model fit. The GFI is calculated by taking the ratio of variability in the expected elements and subtracting it from the variability in the observed elements and subtracting this ratio from one. Thus, it is analogous to a percentage of variance accounted for measure. Conventional interpretation is that values of 0.90 or greater indicate best model fit and values between 0.85 and 0.90 indicate reasonable model fit (Jöreskog and Sörbom, 1993).

Examining the root mean square error of approximation (RMSEA), which is a parsimony of fit index, we find a value of 0.078. This is a parsimony of fit index and lower scores represent better model fit. Values of 0.05 to 0.08 represent good model fit (Browne and Cudek, 1993), thus, the model is parsimonious. Finally, examining the comparative fit index (CFI), which is an index of relative model fit, we obtained a value of 0.91, which is consistent with good model fit (Bentler, 1990).

The correlation between the two latent constructs was 0.83, which is statistically significant ($p < 0.01$). Assessing this path allowed us to estimate whether there is a common higher order factor. The 0.83 correlation indicated that the higher order factor results in 69% common variance among the two subordinate constructs. The standardized coefficients of the symptom loadings for the two-factor model of posttraumatic stress symptoms can be found in Table 2.

4. Discussion

Consistent with the findings of Taylor et al. (1998), we found that the hierarchical model of posttraumatic stress symptoms, which includes the two subordinate factors Intrusion and Avoidance and Hyperarousal and Numbing, provides an adequate account of the relations among symptoms in trauma survivors. While this study represents a systematic replication of the factor structure across laboratories, it is limited by the fact that we utilized one of the same

Table 2
Standardized coefficients of symptom loadings

Symptom		Factor	
		Intrusion and Avoidance	Hyperarousal and Numbing
B1	Intrusive recollections	0.68	
B2	Distressing dreams	0.59	
B3	Flashbacks	0.47	
B4	Psychological distress upon exposure to trauma cues	0.76	
B5	Physiological reactivity upon exposure to trauma cues	0.64	
C1	Cognitive avoidance	0.73	
C2	Behavioral avoidance	0.80	
C3	Event related amnesia		0.32
C4	Diminished interest or participation in activities		0.77
C5	Feelings of detachment from others		0.84
C6	Restricted range of affect		0.80
C7	Sense of foreshortened future		0.69
D1	Sleep difficulties		0.63
D2	Irritability and anger		0.67
D3	Difficulty with concentration		0.79
D4	Hypervigilance	0.52	
D5	Exaggerated startle response	0.51	

trauma populations as that in the Taylor et al. study (MVA survivors). Future research should attempt to replicate this factor structure across trauma populations (e.g. sexual assault, natural disaster).

Worthy of note is the fact that both the hypervigilance and increased startle response symptoms load on the Intrusion and Avoidance factor. These two symptoms have generally been categorized as hyperarousal symptoms. Hypervigilance is a vaguely defined term, however, it is generally accepted that it is some type of strategic cognitive mechanism aimed at minimizing danger and enhancing safety. Thus, it is appropriate that this 'cognitive' symptom loads on the same factor as the intrusive cognitive phenomena (e.g. intrusive recollections, flashbacks, etc.).

Increased startle reaction has been documented by experimental psychophysiological studies with trauma victims high in PTSD symptomology (e.g. Shalev et al., 1992). This exaggerated startle may be a function of an increased tonic level of physiological arousal. In summarizing the experimental literature on physiological responding to trauma relevant cues, Blanchard (1990) noted that trauma victims with PTSD do indeed show a heightened level of tonic arousal relative to traumatized non-PTSD patients and normal controls (see Blanchard, 1990 and Blanchard and Buckley, in press, for reviews). The same studies reveal that PTSD populations show greater sympathetic nervous system reactivity upon exposure to trauma reminiscent cues than traumatized non-PTSD populations. Thus, it may be the case that the strength of conditioning associated with the initial trauma sets the stage for higher order conditioning to take place such that numerous environmental cues serve as trauma relevant cues that elicit the physiological and emotional correlates of anxiety for trauma survivors.

Some have speculated that chronic physiological reactivity to conditioned stimuli may disrupt normal sympathetic nervous system function and result in increased tonic levels of arousal (Kolb, 1987). Such a constant state of negative affective and physiological reactivity might well motivate trauma survivors to engage in some type behavioral avoidance of the provocative stimuli. Thus, a strong conditioned response at the time of the initial trauma may set the stage for complex relations between the symptoms of re-experiencing, physiological arousal, and exaggerated startle response. These studies may help to explain why exaggerated startle response is related to the re-experiencing symptoms that are often accompanied by physiological arousal and why this symptom would load onto the Intrusion and Avoidance factor.

The hyperarousal symptoms in this two factor model that are related to the numbing symptoms are those symptoms which are secondary to an increased tonic level of physiological arousal; specifically, sleep disturbance, irritability and anger, and difficulty with concentration. In contrast, reactivity to environmental cues, trauma-related or unexpected, are functionally similar to the other re-experiencing symptoms.

It is also of interest that the symptoms which load on this second factor are very reminiscent of depression (e.g. anhedonia, restricted range of affect, estrangement from others, sense of foreshortened future, sleep disturbance, difficulty concentrating, and irritability/anger), a point we have made in previous papers (Blanchard et al., in press).

Future revisions of the diagnostic criteria for PTSD should be based on empirical criteria. Should this two-factor model of posttraumatic stress symptoms prove reliable across trauma types, it may be particularly helpful for appropriate diagnosis of trauma victims. The model should also further help us to understand the functional relations among the complex and varied symptomology of trauma survivors.

Diagnosis based on these two symptom clusters rather than the current three symptom clusters would also be important from a patient care point of view. As noted previously, the current diagnostic system allows for very symptomatic patients to go undiagnosed because they fall below the cluster threshold for diagnosis. However, it is well documented that the number and severity of PTSD symptoms are linearly related to impairment on psychopathology and major role functioning variables (Blanchard et al., 1994; Buckley et al., 1996; Kulka et al., 1990). Thus, the current diagnostic criteria do not have good specificity for identifying 'caseness'. In an era of managed care, when reimbursement for behavioral health care is often contingent upon a 'diagnosable condition' for which there is an empirically validated treatment (Barlow, 1994), the current diagnostic criteria have the potential to leave patients who are in need of services, untreated.

The current two-factor model has some potential advantages over the DSM system for a number of reasons. It is empirically derived and thus, may help us to understand the complex relationship among posttraumatic stress symptoms. A more detailed understanding about these symptoms may ultimately lead to more efficacious treatments. Secondly, because it is more parsimonious than the current three symptom cluster diagnostic system, it may have a greater sensitivity for identifying caseness. Future research should aim at systematic replication of this two factor model across trauma types. In addition, the sensitivity/specificity of this two factor model to detect caseness awaits future investigation.

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