Journal of Traumatic Stress, Vol. 18, No. 6, December 2005, pp. 667–676 (© 2005)

Multisample Cross-Validation of a Model of Childhood Posttraumatic Stress Disorder Symptomatology

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This study is the latest advancement of our research aimed at best characterizing children's posttraumatic stress reactions. In a previous study, we compared existing nosologic and empirical models of PTSD dimensionality and determined the superior model was a hierarchical one with three symptom clusters (Intrusion/Active Avoidance, Numbing/Passive Avoidance, and Arousal; Anthony, Lonigan, & Hecht, 1999). In this study, we cross-validate this model in two populations. Participants were 396 fifth graders who were exposed to either Hurricane Andrew or Hurricane Hugo. Multisample confirmatory factor analysis demonstrated the model's factorial invariance across populations who experienced traumatic events that differed in severity. These results show the model's robustness to characterize children's posttraumatic stress reactions. Implications for diagnosis, classification criteria, and an empirically supported theory of PTSD are discussed.

A substantial body of clinical and research literature supports the validity of posttraumatic stress disorder (PTSD) in adult and child victims of trauma; however, some important issues concerning the conceptualization and diagnosis of PTSD are unresolved. Reviews of the literature highlight the need to validate the component symptom categories outlined by the *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition (*DSM-IV*; American Psychiatric Association, 1994), and to establish empirically symptoms that are central versus peripheral to the disorder (Green, 1991; Lonigan, Phillips, & Richey, 2003; Vogel & Vernberg, 1993). Furthermore, there is little systematic research on potential trauma-related differences in the symptomatic expression and conceptualization of PTSD (e.g., variations in symptom expression or clustering due to type, severity, or duration of traumatic exposure). Research addressing these gaps in the literature is lacking especially with regard to child victims of trauma, in part, because the diagnosis was developed for adults based upon descriptions of war veterans.

Anthony, Lonigan, and Hecht (1999) used confirmatory factor analysis (CFA) with a large sample of children and adolescents ($N = 5{,}664$) exposed to Hurricane Hugo to evaluate all existing nosologic and empirical models of PTSD symptom clusterings. The nosologic models evaluated included those from the *Diagnostic and Statistical Manual of Mental Disorders*, third edition, revised (*DSM-III-R*; American Psychiatric Association, 1987),

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 • Published online in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/jts.20075

DSM-IV (American Psychiatric Association, 1994), and International Classification of Diseases, Version 10 (ICD-10; World Health Organization, 1993). Of these three nosologic models and nine empirical models, only two provided acceptable characterizations of the symptom data (i.e., comparative fit index > .90). Statistical comparisons of model fits revealed that one of the empirical models was clearly superior. This model, like the *DSM* and ICD models, had three factors that reflect intrusion, numbing, and arousal; however, the best fitting model distinguished passive avoidance of interpersonal relations from active avoidance of trauma-related thoughts or situational cues. Passive avoidance of interpersonal relations was part of the Numbing/Passive Avoidance factor, and active avoidance of trauma-related thoughts and situational cues was part of the Intrusion/Active Avoidance factor. This model also included a unifying second-order factor that explained the covariation among the three first-order factors. That is, a higher order PTSD factor accounted for the correlations between the three lower order factors. Convergent evidence for this model comes from factor analytic studies (e.g., McFall, Smith, Mackay, & Tarver, 1990; Weathers & Litz, 1993) employing the Mississippi Scale for Combat-Related PTSD (Keane, Caddell, & Taylor, 1988). For example, King and King (1994) demonstrated that this model well explained the symptom data of approximately 1,400 Vietnam veterans. Convergent evidence in favor of a hierarchical structure of PTSD comes from studies by King and King and by Taylor, Kuch, Koch, Crockett and Passey (1998).

That the best fitting model from Anthony et al. (1999) differed from current nosologies was not surprising. Studies of children's PTSD symptoms have reported low internal-consistency values for the *DSM* symptom clusters (Shannon, Lonigan, Finch, & Taylor, 1994; Vernberg, La Greca, Silverman, & Prinstein, 1996). Similarly, symptoms from particular *DSM* symptom clusters have often loaded on different factors that have been derived empirically from reports of children's and adolescents' PTSD symptoms (Dyregrov, Kuterovac, & Barath, 1996; Pynoos et al., 1987; Sack, Seeley, & Clarke, 1997). Finally, diagnostic efficacy studies have shown that the *DSM* arousal cluster and some *DSM* PTSD symptoms have poor diagnostic utility in child and adolescent trauma victims (Lonigan, Anthony, & Shannon, 1998; Pynoos et al., 1993; Sack et al., 1997).

To examine whether the best fitting model from Anthony et al. (1999) adequately describes the posttraumatic stress reactions of children and adolescents, it will be necessary to evaluate how well it characterizes the dimensionality of PTSD symptoms experienced by different subpopulations who experience different types of trauma and who are evaluated with different assessment tools. Optimally, data from multiple populations or multiple measures should be included in a single study so that the invariance of PTSD dimensionality across the different populations, types of trauma, or assessment tools can be examined (Lonigan et al., 2003). Such research is particularly warranted concerning trauma differences because research indicates that victims of violence (Pynoos et al., 1987), victims of abuse, and victims of more severe natural disasters (Garrison et al., 1995; Pynoos et al., 1993) exhibit more severe PTSD symptoms than victims of less severe traumatic events (Lonigan et al., 2003).

The goal of the present study was to evaluate the best fitting model from Anthony et al. (1999) when simultaneously applied to populations of children and adolescents exposed to different traumatic events. We employed multisample CFA to determine how well this three-factor model, with distinct passive and active avoidance clusters, characterized PTSD dimensionality across victims of natural disasters that differed substantially in severity of impact on the community and in severity of impact on the individuals investigated. A key advantage of this multisample CFA approach was that all aspects of the model could be evaluated statistically within and across groups. Multisample CFA allowed a priori specification of the theoretical model in both groups and generated fit indices that quantified how well the model performed within and across the two populations. Moreover, the analyses permitted tests of trauma-related differences in the centrality of individual symptoms and symptom clusters.

Method

Participants

Part of the data for this study was drawn from a sample of 5,664 students in Grades 5 through 12 of the Berkeley County, South Carolina school system who were assessed approximately 3 months following Hurricane Hugo. Other data were drawn from a sample of 568 students in Grades 3 through 5 of a South Florida school system who were assessed approximately 3 months following Hurricane Andrew. Although both samples lived through hurricanes, the two samples experienced hurricanes that differed dramatically in severity and duration of impact on the community.

Hurricane Hugo was a Category IV cyclone over water and at landfall (September 21, 1989). Hugo was responsible for over $6 billion in property damage and 13 deaths. Within this sample, approximately 35% of the children reported damage to their homes due to the hurricane, 7.5% reported that they had to move to a new home, and 3.5% reported that one or both of their parents had become unemployed as a result of the hurricane (for a complete sample description, see Shannon et al., 1994). Hurricane Andrew was a Category V cyclone over water and at landfall (August 24, 1992). It was one of only three Category V cyclones to ever make landfall in the United States. Hurricane Andrew was responsible for $26.5 billion in damages, including destruction of 25,524 homes and damage to another 101,241 homes. Andrew was directly responsible for 26 fatalities and indirectly responsible for another 65 fatalities. Within this sample, approximately 61% of the children reported damage to their homes, 27% reported that they had to move to a new home, and 13% reported that one or both of their parents had become unemployed as a result of the hurricane (for a complete sample description, see Vernberg et al., 1996).

Only fifth-grade children from both samples were included in this study to assure that sample differences were not due to age-related differences in symptom presentations. All 198 fifth graders in the Andrew sample were included. Given the larger number of fifth graders in the Hugo sample ($n = 814$), we matched the ethnic breakdown of the Hugo sample to that of the Andrew sample as closely as possible to reduce potential confounding of the severity of traumatic event with ethnic- or culture-related differences in symptom presentations. Specifically, all non-African American minorities from the Hugo sample were included, given the high proportion of Hispanics in the Andrew sample. Next, because the Hugo sample had more African American and Caucasian participants than the Andrew sample, we randomly selected children from these ethnic groups of the Hugo sample. None of the participants selected for this analysis had missing data. Table 1 summarizes the demographic information for both samples used in this study. The Andrew sample had a notably higher proportion of girls and Hispanic Americans than the Hurricane Hugo sample. Children who experienced Hurricane Andrew also reported significantly more severe PTSD symptoms as measured by the total score on the Frederick Reaction Index for Children (RI; Frederick, 1985), $F(1, 394) = 14.09$, $p < .001$.

Table 1. Demographic Information by Sample

	Hugo Sample	Andrew Sample
Sample Size	198	198
Mean Age (*SD*)	10.6 (.70)	10.3 (.60)
Sex		
Male	51.0%	40.0%
Female	49.0%	59.6%
Ethnicity		
Caucasian	42.4%	34.3%
African American	39.4%	26.3%
Asian American	6.6%	2.5%
Hispanic American	2.0%	31.3%
Other	9.6%	5.6%
Reaction Index Mean (*SD*)	27.7 (13.7)	33.1 (14.9)

Measures

Children in both samples completed modified versions of the RI to assess the frequency of PTSD symptoms. These 20-item self-report versions were patterned after the adult self-report version (Frederick, 1987), but the language was modified to facilitate comprehension of the items by children [i.e., "I reexperience disturbing scenes about the (hurricane) physically or emotionally" was changed to "I keep seeing or hearing things in my mind that remind me of what happened"]. The two versions of the RI used in this study differed only slightly in the wording of items (i.e., items in the version used with the Andrew sample used the word "you" instead of "I;" see previously mentioned change), and the version used with the Andrew sample provided examples of activities for the anhedonia item.). However, the measure used with the Hugo sample employed a 5-point Likert scale whereas the measure used with the Andrew sample employed a 3-point Likert scale. These two versions of the instrument had identical endpoints and midpoint (i.e., *none of the time*, *some of the time*, and *most of the time*), and parallel scoring of these common points maintained comparability, i.e., 0, 2, and 4. Research with children supports the validity of the RI through correlations of .90 with clinically confirmed cases of PTSD (Frederick, 1985; Pynoos et al., 1993).

The self-report questionnaire versions of the RI used in the present study are sensitive to the degree that children are exposed to a traumatic event (Lonigan, Shannon, Finch, & Daugherty, 1991; Pynoos et al., 1987) and to the intensity of emotional experience during a traumatic event (Lonigan, Shannon, Taylor, Finch, & Sallie, 1994; Schwarz & Kowalski, 1991). The two versions used in the present study demonstrated high internal consistencies when considered as a whole, αs = .83 and .89, and moderate to high internal consistencies when examined by *DSM-IV* symptom clusters of Reexperiencing the Traumatic Event, αs = .86 and .75, Emotional Numbing/Avoidance, αs = .55 and .64, and Increased Arousal, αs = .57 and .57 (Anthony et al., 1999, and Vernberg et al., 1996, respectively).

Children completed the RI as part of a group administration in their schools approximately 3 months after Hurricane Hugo or Hurricane Andrew. Teachers or researchers read the items aloud while children followed

Table 2. Reaction Index Item Mappings and Standardized Factor Loadings From the Constrained Multisample Model

		Unstandardized Factor Loadings (SEs)		Standardized Factor Loadings	
RI Item or First-Order Factor	Factor	Hugo	Andrew	Hugo	Andrew
	First-Order Structure				
Avoid thoughts of event	Intrusion/Active Avoidance	1.11 (.09)	1.11 (.09)	.76***	.76***
Repetitive images or sounds	Intrusion/Active Avoidance	1.00 –[a]	1.00 –[a]	.68***	.68***
Upset by reminders	Intrusion/Active Avoidance	0.95 (.08)	0.95 (.08)	.67***	.67***
Bad dreams	Intrusion/Active Avoidance	0.75 (.07)	0.75 (.07)	.66***	.53***
Fear of reoccurrence	Intrusion/Active Avoidance	0.85 (.08)	0.85 (.08)	.59***	.59***
Avoid situational cues	Intrusion/Active Avoidance	0.96 (.09)	0.96 (.09)	.57***	.57***
Upset by thoughts of event	Intrusion/Active Avoidance	0.69 (.10)	1.01 (.09)	.51***	.74***
Emotional isolation/estrangement	Numbing/Passive Avoidance	1.22 (.11)	1.22 (.11)	.70***	.70***
Emotional numbing	Numbing/Passive Avoidance	1.00 –[a]	1.00 –[a]	.68***	.68***
Emotional avoidance	Numbing/Passive Avoidance	1.10 (.10)	1.10 (.10)	.67***	.67***
Anhedonia	Numbing/Passive Avoidance	0.29 (.11)	0.29 (.11)	.16**	.16**
Easily startled	Arousal	1.00 –[a]	1.00 –[a]	.59***	.59***
Reactive physiology/somatic problems	Arousal	1.05 (.12)	1.05 (.12)	.57***	.57***
Sleep problems	Arousal	0.61 (.10)	0.61 (.10)	.36***	.36***
Attention problems	Arousal	0.28 (.10)	0.28 (.10)	.16**	.16**
Memory/learning probs	Arousal	0.24 (.16)	1.04 (.14)	.12	.62***
	Second-Order Structure				
Intrusion/Active Avoidance	Posttraumatic Stress	0.94 (.07)	0.94 (.07)	.94***	.94***
Numbing/Passive Avoidance	Posttraumatic Stress	0.74 (.06)	0.74 (.06)	.90***	.90***
Arousal	Posttraumatic Stress	0.84 (.08)	0.84 (.08)	.97***	.97***

Note. RI = Posttraumatic Stress Disorder Reaction Index.
[a]Parameters fixed to 1.00 to identify the model.
** $p < .01$. *** $p < .001$.

along on their own copies of the questionnaires and marked their responses. RI items, representing symptom severities, were mapped onto the a priori model according to the exploratory and CFA findings of Anthony et al. (1999), King and King (1994), McFall et al. (1990), and Weathers and Litz (1993). Four of the 20 RI items (i.e., Identify event as traumatic, guilt, sense of foreshadowing, reckless behavior) were not mapped onto a factor because they are not diagnostic indicators of specific symptom clusters according to current nosologies, other existing empirical models, or clinical tradition (see Anthony et al., 1999). Table 2 details the mapping of the 16 RI items onto the model's first-order factors.

Results

Preanalysis Evaluation of Data and Measurement Models

Because the sample sizes were likely insufficient to generate stable parameter estimates from analyses of polychoric correlations, multisample polychoric analyses may have inappropriately accepted the null hypothesis of no group differences as a mere function of low power for such analyses. Therefore, we chose to treat the ordinal data as interval data. As a check on this decision, we performed single group CFAs on polychoric correlations and covariance matrices. Patterns of factor loadings across the two methods of analysis were equivalent, and the only differences in results were that analyses of polychoric correlations yielded higher model fits (see Table 3).

Preanalysis inspection of the assumed interval data revealed that multivariate outliers were participants who reported the most severe symptomatology. We included these outliers because we deemed it important to evaluate the adequacy of the model across the full range of posttraumatic stress responses. Histograms and normality statistics revealed that many variables were positively skewed and the data were multivariate nonnormal, especially in the Hugo sample. Implications of nonnormality were taken into account through use of the Robust Maximum Likelihood estimation method, the Satorra-Bentler scaled chi-square (S-Bχ^2), and adjustments to the standard errors to the extent of the nonnormality (Bentler & Dudgeon, 1996). Prior to multisample CFA, single group

Table 3. Model Fit Indices for Single Group Analyses

Sample	Basis of Analyses	df	χ^2	AIC	CFI	TLI	RMSEA
Andrew	Covariance	101	118.1	−83.9	.98	.98	.03
Andrew	Correlation	101	57.7	−144.3	1.00	1.06	.00
Hugo	covariance	101	174.5***	−27.5	.90	.88	.06
Hugo	correlation	101	98.4	−103.6	1.00	1.00	.00

Note. ns = 198. Correlation analyses were of polychoric correlations among ordinal variables. Covariance analyses assumed that the data were interval and that deviations from nonnormality were accounted for by Robust Maximum Likelihood estimation method, the Satorra-Bentler scaled chi-square, and adjustments to the SEs to the extent of the nonnormality. df = degrees of freedom; χ^2 = Satorra-Bentler chi-square; AIC = Akaike Information Criterion; CFI = comparative fit index; TLI = Tucker Lewis index; RMSEA = Root Mean Squared Error of Approximation.
$^{***}p < .001$.

CFAs evaluated the adequacy of the a priori three-factor model in each sample in terms of overall model fit and statistical inspection of factor loadings. All models converged cleanly. The a priori model provided exceptionally good fits to the data from the Andrew sample (see Table 3); that is, the Satorra-Bentler scaled chi-square was nonsignificant ($p > .10$), Comparative Fit Index and Tucker-Lewis Index were greater than .95, Root Mean Squared Error of Approximation was less than .05, and Akaike Information Criterion was low. In contrast, the model provided a less than ideal, but still reasonably good fit to the data from the Hugo dataset (see Table 3).

Regarding the reliability of individual model parameters, most observed variables in the Andrew sample had at least moderate standardized loadings (λs > .44, zs > 4.94, ps < .001) on their respective first-order factors in the CFA. Exceptions included "anhedonia" ($\lambda = .13, z = 1.78, ns$) and "attention problems" ($\lambda = .24, z = 2.94, p < .01$). With data from the Hugo sample, again, most observed variables had at least moderate and significant first-order factor loadings (λs > .28, zs > 3.44, ps < .001). Exceptions included "anhedonia" ($\lambda = .18, z = 2.23, p < .05$), "attention problems" ($\lambda = .07, z = .79, ns$), and "learning/memory problems" ($\lambda = .13, z = 1.59, ns$). For both samples, second-order factor loadings were large in magnitude, and all were significant (λs $\geq$ .87, zs > 6.79, ps < .001).

Multisample CFA

Multisample CFA was used to examine factorial invariance across severity of traumatic experience (see Table 4). The good fit of the unconstrained multisample model demonstrated that the a priori model provided a good fit to the symptom data across populations. Constraining all first-order factor loadings to equality across samples resulted in a reliable reduction in model fit, $\chi^2_{\text{diff}}(13, N = 396) = 35.4, p < .001$. The Lagrange multiplier test indicated that releasing two first-order constraints would individually and collectively improve the model fit at the $p < .01$ level. Specifically, "learning/memory problems" was a better indicator of Arousal in the Andrew sample than in the Hugo sample, and "having upsetting thoughts about the disaster" was a

Table 4. Levels of Multisample Equivalence

Invariance Constraints	df	χ^2	AIC	CFI	TLI	RMSEA	χ^2diff[a]	χ^2diff[b]
Base model (no cross-group constraints)	202	294.2	−109.8	.942	.931	.034	–	–
Constrain first-order factor loadings	215	329.6	−100.4	.928	.920	.037	35.4***	35.4***
Free learning/memory problems	214	315.7	−112.3	.936	.929	.035	13.9***	21.5*
Free thoughts upset	213	309.0	−117.0	.940	.932	.034	6.7**	14.8
Constrain second-order factor loadings	216	312.1	−119.9	.940	.933	.034	3.1	17.9
Constrain uniquenesses	233	347.9	−118.1	.928	.926	.035	35.8**	53.7**
Free bad dreams uniqueness	232	330.5	−133.5	.938	.936	.033	17.4***	36.3

Note. $N = 396$. All model fits had $ps < .001$. df = degrees of freedom; AIC = Akaike Information Criterion; CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = Root Mean Squared Error of Approximation.
[a]Compares a model's chi-square to the previous model's chi-square. [b]Compares a model's chi-square to the unconstrained model's chi-square.
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

better indicator of Intrusion/Active Avoidance in the Andrew sample than in the Hugo sample. Constraining the second-order factor loadings resulted in an equivalent fit, χ^2_{diff} (1, $N = 396$) = 3.1, *ns*, that also was equivalent to the base model, χ^2_{diff} (14, $N = 396$) = 17.9, *ns*. The stringent test of constraining uniquenesses to equality resulted in a reliable reduction in model fit, χ^2_{diff} (17, $N = 396$) = 35.8, $p < .01$; however, once the uniqueness of "bad dreams" was released, the highly constrained multisample model still fit as well as the completely unconstrained multisample model, χ^2_{diff} (30, $N = 396$) = 36.3, *ns*. Both unstandardized and standardized factor loadings for the highly constrained multisample model are shown in Table 2.

Discussion

This study demonstrated that children who experience natural disasters of different magnitudes manifest highly similar posttraumatic stress reactions. These reactions are characterized by three symptom clusters and a unifying, second-order posttraumatic stress construct. The three symptom clusters correspond to intrusive phenomena coupled with active avoidance of such negative experiences, emotional numbing along with passive avoidance of emotionally unrewarding activities, and arousal. This study provided an essential cross-validation and extension of this hierarchical model of PTSD dimensionality and further demonstrated its utility across different populations of child trauma victims.

Multisample CFA demonstrated that a three-factor hierarchical model adequately described the posttraumatic stress reactions of children across traumatic events; however, tests of factorial invariance across samples revealed some trauma-specific associations. Specifically, upsetting thoughts about the traumatic event and learning/memory problems were stronger and more reliable indicators of their respective symptom clusters in the Andrew sample than in the Hugo sample. These differences, though reliable, were quite small in magnitude as evidenced by only minor changes in model fit indices when multisample constraints were released. Thus, for all practical purposes, not only was the general factor structure the same in both samples but all of the specific relations among observed symptom severities and among latent posttraumatic stress indicators also were the same in both samples.

This study demonstrated that children's posttraumatic stress reactions were not qualitatively different, even when they were quantitatively different. That is, the children who experienced Hurricane Andrew reported significantly more severe PTSD symptoms than children who experienced Hurricane Hugo; however, children's posttraumatic stress reactions had consistent dimensionality across samples. These results suggest that researchers and mental health workers should conceptualize posttraumatic stress as being of one kind that lies on a continuum of disturbance severity. Such findings are more in line with a dimensional conceptualization of PTSD than with a categorical taxonomy that implies qualitatively different posttraumatic stress reactions (e.g., PTSD vs. no disorder).

The finding of equivalent PTSD dimensionality across severity of traumatic experience extends the findings of Anthony et al. (1999) that PTSD dimensionality also is equivalent across late childhood, early adolescence, and late adolescence. Moreover, the model of PTSD dimensionality examined in the present study and in Anthony et al. closely resembles one that originated from over 2,200 male and female Vietnam veterans who completed a different symptom measure approximately 20 years' posttrauma (King & King, 1994). Synthesizing results from these three studies suggests that PTSD dimensionality is stable across severity of traumatic experience, age of exposure to trauma, type of trauma, means of measuring PTSD symptomatology, and time elapsed since trauma. The apparent robustness of this model supports its potential for general clinical usage.

The consistent pattern of first-order factor loadings in the two samples has potentially important implications for the diagnosis of PTSD in children. Our findings suggest that some PTSD symptoms are more central to posttraumatic stress reactions than others. That is, although most symptoms were moderately and reliably related to the underlying dimensions of posttraumatic stress, there were exceptions. For example, anhedonia was an equally poor indicator of posttraumatic stress in both populations. Attention problems also was an equally poor indicator of posttraumatic stress in both populations. Finally, learning and memory problems was a poor indicator of posttraumatic stress in the Hugo sample, but was a reasonable indicator in the Andrew sample. These findings suggest that anhedonia, attention problems, and perhaps learning/memory problems are not central to organized posttraumatic stress reactions. Instead, they are the most common symptoms (Garrison et al., 1995; Green et al., 1991; Lonigan et al., 1998) that are least predictive of PTSD (Lonigan et al., 1998; Pynoos et al., 1993; Sack et al., 1997). Thus, it seems that these symptoms are markers of exposure to trauma that reflect normal disruptive consequences rather than markers of an organized pathological reaction (Lonigan et al., 2003). Accordingly, they may be more appropriately considered associated, rather than diagnostic, features of PTSD; however, for the duration of time that these symptoms remain diagnostic features, it will be important for *DSM* to continue requiring for a diagnosis of PTSD more symptoms from the Increased Arousal and Numbing/Avoidance clusters than from the Reexperiencing cluster to assure reliable diagnosis.

The model supported in the present study differs from the *DSM-IV* model in three important ways. The most noteworthy difference is in the placement of avoidance symptoms. Whereas *DSM-IV* considers all avoidance symptoms part of the Numbing/Avoidance cluster, reflecting early theories of PTSD (e.g., Horowitz, 1976), the best-fitting model distinguishes symptoms of active or effortful avoidance and those of passive or automatic avoidance. Specifically, effortful avoidance symptoms (i.e., purposeful engagement in thoughts, conversations, or situations unrelated to the trauma to avoid reminders of the trauma) belong on the factor that reflects Intrusion/Active Avoidance, and passive avoidance symptoms (i.e., not engaging in social interactions or affective experiences) belong on the factor that reflects Numbing/Passive Avoidance.

Potential explanations for why active and passive avoidance symptoms belong on different factors include that they reflect separate avoidance mechanisms (e.g., Foa, Zinbarg, & Rothbaum, 1992), separate motivational systems (i.e., behavioral activation system vs. behavioral inhibition system; Gray, 1975, 1976, 1982) that respond to different types of environmental signals, or separate dimensions of biobehavioral responses to trauma (Vernberg & Varela, 2001). From a neurobiological perspective, trauma victims may actively avoid or escape aversive trauma-related thoughts by engaging in unrelated thoughts, conversations, or behaviors. They also may refrain from activities such as social interactions as a passive means of avoiding the frustration that results after trauma when these activities are no longer emotionally rewarding. This distinction between active and passive avoidance symptoms in PTSD is supported by other factor analytic studies (Foa, Riggs, & Gershuny, 1995; King & King, 1994; Sack et al., 1997; Taylor et al., 1998), and it represents a theoretical conceptualization of PTSD that is consistent with neurobiological research on learning and motivation in animals (e.g., Gray, 1975) and neurobiological research on psychopathology in humans (e.g., Fowles, 1980).

From a biobehavioral and cognitive perspective, recurrent intrusive thoughts may reflect struggles to incorporate or accommodate violations of schemas relating to safety, personal boundaries, and control. These intrusive symptoms may involve fear structures comprised of memory networks that activate escape or avoidance behavior in the presence of perceived threat (Foa & Kozak, 1991). Exposure-based therapies appear to reduce these symptoms (Vernberg & Johnston, 1991). Passive avoidance, on the other hand, may reflect sequelae of activating an extended freeze–surrender response (Perry, 1997; Perry, Pollard, Blakely, Baker, & Vigilante, 1995). This extreme physiological response is thought to accompany symptoms of dissociation and estrangement; recurrence of such symptoms may provoke feelings of despair and isolation rather than active avoidance.

Regardless of the utility of these theories to explain PTSD, the consistent findings across different populations, types of trauma, and assessment tools suggest that the clinical picture of PTSD would be more accurately portrayed if symptoms of emotional numbing and symptoms of effortful avoidance of thoughts and situations associated with the trauma were placed on separate symptom clusters. However, we believe that placement of thought avoidance in the Intrustion/Reexperiencing cluster needs further evaluation prior to adoption of this new model because the RI item used to assess this symptom was a complex two-part item that also inquired about recurrent thoughts of the traumatic event. Future research should assess recurrent thoughts of the traumatic event independently from repeated attempts to actively avoid having these thoughts through engaging in other thoughts or activities.

The present model also differs from current classification systems of mental disorders concerning the placement of fear of reoccurrence/hypervigilance. Model development techniques and cross-validations (e.g., Anthony et al., 1999; the present study) indicate that this symptom belongs on the Intrusion/Active Avoidance factor rather than on the Arousal factor (see also Taylor et al., 1998). Therefore, it appears that fear of reoccurrence and hypervigilance are manifestations of distressing, trauma-related thoughts rather than direct causes or consequences of increased arousal; however, it remains possible that fear of reoccurrence belongs on the Intrusion/Active Avoidance factor and that hypervigilance belongs on the Arousal factor because fear of reoccurrence, solely measured in the present study, may not capture all of what hypervigilance represents. Exploratory factor analytic studies have been inconsistent in their placement of hypervigilance (Foa et al., 1995; Hendrix, Anelli, Gibbs, & Fournier, 1994; Sack et al., 1997; Taylor et al., 1998). CFA studies that independently assess fear of reoccurrence and hypervigilance are needed to clarify this issue.

The model that was cross-validated in the present study also differs from *DSM-IV* in that the present model, like the *DSM-III-R* model, places physiological reactivity in the Increased Arousal cluster rather than in the Intrusion/Reexperiencing cluster. An important qualification of this placement is that physiological reactivity was indexed by children's self-reported increases in somatic complaints since the traumatic event. Although consistent with the literature on children's responses to trauma, children's somatic complaints might reflect a different domain of disturbance than that reflected by adults' physiological reactivity to cues of the trauma.

Of course, a definitive answer to the PTSD dimensionality question cannot be obtained from any single study. The present study exemplified a method of inquiry that we believe to be most fitting, given where the field is currently positioned for answering this question. That is, the first step involved identification of a number of models of PTSD dimensionality that were plausible according to current theory and empirical research. In the second step, Anthony et al. (1999) evaluated and statistically compared the utility of all alternative models to accurately characterize children's and adolescents' posttraumatic stress reactions to arrive at a superior model. The third step, exemplified by the present study, involved cross-validating this model. Although the present study extended the model to populations who experienced more or less severe natural disasters, additional studies are needed to extend the model to other populations, types of trauma, and assessment techniques to arrive at an adequately cross-validated conceptualization of PTSD. Specifically, studies should examine symptom data from different populations (e.g., age, sex, and ethnic group), types of trauma (e.g., warfare, violent crime, child abuse, and domestic violence), symptom measures (e.g., self-report and structured interview), and posttrauma phases [e.g., within first month (acute stress disorder) and beyond (PTSD)] using multisample CFA to examine the invariance of PTSD dimensionality across the range of these variables.

Because the constellation of symptoms required for a diagnosis of PTSD in children was adapted directly from those specified for adults (Cohen, 1998), a number of issues have been raised regarding the suitability of applying the traditional *DSM* diagnosis and diagnostic criteria to younger populations (Lonigan et al., 2003). Given differences in social, cognitive, verbal, experiential, and other factors between children and adults and between younger and older children, it is possible that children may manifest different patterns of reactions following trauma in relation to adults and in relation to where they fall on a developmental continuum. Indeed, the *DSM-IV* allows for difference in response to the traumatic event and the expression of symptoms depending on the developmental level of the child. Within the reexperiencing symptom cluster, recurrent and intrusive phenomenon may take the form of repetitive play in which themes or aspects of the trauma are expressed. Recurrent and distressing dreams of the event may take the form of frightening dreams without recognizable content, and acting or feeling as if the traumatic event were recurring may be reflected in trauma-specific reenactment.

Given the paucity of data concerning very young children's symptomatic expression of PTSD, it is possible that the more dramatic social, cognitive, and experiential differences between very young children and older youth may yield systematic variations in how PTSD is expressed. However, data from this study and others support a relatively consistent pattern of symptom clustering from middle childhood, through adolescence, into adulthood that represents a variation of the *DSM* model. Although there may be quantitative differences in the rate of symptom expression dependent on age as well as more subtle variations in children's ability to access or report symptoms, there do not appear to be large, qualitative differences in the symptomatic expression of PTSD across this age span.

Note that the present study addressed the dimensionality of PTSD through CFA of only those *DSM* PTSD symptoms that were included in the model found superior by Anthony et al. (1999). Consequently, the present study did not address which dimensions of PTSD were reflected by a few defining symptoms (i.e., psychogenic amnesia, sense of foreshortened future, and irritability); however, it is unlikely that exclusion of a few symptoms would result in changes in the empirical structure of PTSD symptoms, especially given that Foa et al. (1995) found that psychogenic amnesia and sense of foreshortened future did not load on any PTSD factor in their solution. Regardless, additional cross-validation of the present model is needed in which all *DSM* symptoms of PTSD are included, and the complete model should be compared to the complete *DSM-IV* model prior to dramatic nosologic changes.

In summary, the present study supported the construct validity of PTSD in child disaster victims as a unified disorder that manifests in three symptom clusters: Intrusion/Active Avoidance, Numbing/Passive Avoidance, and Arousal. This dimensionality of posttraumatic stress, which differs from the current *DSM* model, appears to be robust across severity of traumatic event, age of victimization, types of trauma, and assessment instruments. This study also provided convergent evidence in favor of distinguishing between active and passive avoidance and to consider anhedonia, learning/memory difficulties, and attention difficulties as associated features of PTSD rather than as strong diagnostic indicators. Finally, this report benefits those in child clinical service by providing a useful and empirically supported conceptualization of PTSD in a time of emphasis on empirically validated clinical practice.

Acknowledgments

Portions of this work were supported by a grant from the Medical University of South Carolina Institutional Research Fund, a NICHD Postdoctoral Fellowship through the John F. Kennedy Center at Vanderbilt University, and by a grant from the BellSouth Foundation.

References

American Psychiatric Association. (1987). Diagnostic and statistical manual of mental disorders (3rd ed., Rev.). Washington, DC: Author.

American Psychiatric Association. (1994). Diagnostic and statistical manual of mental disorders (4th ed.). Washington, DC: Author.

Anthony, J.L., Lonigan, C.J., & Hecht, S.A. (1999). Dimensionality of posttraumatic stress disorder symptoms in children exposed to disaster: Results from confirmatory factor analyses. Journal of Abnormal Psychology, 108, 326–336.

Bentler, P.M., & Dudgeon, P. (1996). Covariance structure analysis: Statistical practice, theory, and directions. Annual Review of Psychology, 47, 563–592.

Cohen, J.A. (1998). Practice parameters for the assessment and treatment of children and adolescents with posttraumatic stress disorder. Journal of the American Academy of Child and Adolescent Psychiatry, 37, 997–1001.

Dyregrov, A., Kuterovac, G., & Barath, A. (1996). Factor analysis of the Impact of Events Scale with children in war. Scandinavian Journal of Psychology, 37, 339–350.

Foa, E.B., & Kozak, M.J. (1991). Emotional processing: Theory, research, and clinical implications for anxiety disorders. In J.D. Safran & L.S. Greenberg (Eds.), Emotion, psychotherapy, and change (pp. 21–49). New York: Guilford Press.

Foa, E.B., Riggs, D.S., & Gershuny, B.S. (1995). Arousal, numbing, and intrusion: Symptom structure of PTSD following assault. American Journal of Psychiatry, 152, 116–120.

Foa, E.B., Zinbarg, R., & Rothbaum, B.O. (1992). Uncontrollability and unpredictability in post-traumatic stress disorder: An animal model. Psychological Bulletin, 112, 218–238.

Fowles, D.C. (1980). The three arousal model: Implications of Gray's two-factor learning theory for heart rate, electrodermal activity, and psychopathy. Psychophysiology, 17, 87–104.

Frederick, C.J. (1985). Children traumatized by catastrophic situations. In S. Eth & R.S. Pynoos (Eds.), Post-traumatic stress disorders in children (pp. 73–99). Washington, DC: American Psychiatric Press.

Frederick, C.J. (1987). Psychic trauma in victims of crime and terrorism. In G.R. VandenBos & B.K. Bryant (Eds.), Cataclysms, crises, and catastrophes: Psychology in action. The master lectures, Vol. 6. (pp. 55–108). Washington, DC: American Psychological Association.

Garrison, C.Z., Bryant, E., Add, C.L., Spurrier, P.G., Freedy, J.R., & Kilpatrick, D.G. (1995). Posttraumatic stress disorder in adolescents after Hurricane Andrew. Journal of the American Academy of Child and Adolescent Psychiatry, 34, 1193–1201.

Gray, J.A. (1975). Elements of a two-process theory of learning. New York: Academic Press.

Gray, J.A. (1976). The behavioral inhibition system: A possible substrate for anxiety. In M.P. Feldman & A. Broadhurst (Eds.), Theoretical and experimental bases of the behavior therapies (pp. 3–41). London: Wiley.

Gray, J.A. (1982). The neuropsychology of anxiety: An inquiry into the function of the septo-hippocampal system. Oxford, England: Oxford University Press.

Green, B.L. (1991). Evaluating the effects of disasters. Psychological Assessment, 3, 538–546.

Green, B.L., Korol, M., Grace, M.C., Vary, M.G., Leonard, A.C., Gleser, G.C., & Smitson-Cohen, S. (1991). Children and disaster: Age, gender, and parental effects on PTSD symptoms. Journal of the American Academy of Child and Adolescent Psychiatry, 30, 945–951.

Hendrix, C.C., Anelli, L.M., Gibbs, J.P., & Fournier, D.G. (1994). Validation of the Purdue Post-Traumatic Stress Scale on a sample of Vietnam veterans. Journal of Traumatic Stress, 7, 311–318.

Horowitz, M.J. (1976). Stress response syndromes. New York: Aronson.

Keane, T.M., Caddell, J.M., & Taylor, K.L. (1988). Mississippi Scale for Combat-Related Posttraumatic Stress Disorder: Three studies in reliability and validity. Journal of Consulting and Clinical Psychology, 56, 85–90.

King, L.A., & King, D.W. (1994). Latent structure of the Mississippi Scale for Combat-Related Post-Traumatic Stress Disorder: Exploratory and higher-order confirmatory factor analyses. Assessment, 1, 275–291.

Lonigan, C.J., Anthony, J.L., & Shannon, M.P. (1998). Diagnostic efficacy of posttraumatic symptoms in children exposed to disasters. Journal of Child Clinical Psychology, 27, 255–267.

Lonigan, C.J., Phillips, B.M., & Richey, J.A. (2003). Diagnosis, assessment, and associated features of PTSD in children. Psychiatric Clinics of North America, 12, 171–194.

Lonigan, C.J., Shannon, M.P., Finch, A.J., Jr., & Daugherty, T.K. (1991). Children's reactions to a natural disaster: Symptom severity and degree of exposure. Advances in Behaviour Research and Therapy, 13, 135–154.

Lonigan, C.J., Shannon, M.P., Taylor, C.M., Finch, A.J., Jr., & Sallie, F.R. (1994). Children exposed to disaster: II. Risk factors for the development of posttraumatic symptomatology. Journal of the American Academy of Child and Adolescent Psychiatry, 33, 94–105.

McFall, M.E., Smith, D.S., Mackay, P.W., & Tarver, D.J. (1990). Reliability and validity of the Mississippi Scale for Combat-Related Post-Traumatic Stress Disorder. Psychological Assessment: A Journal of Consulting and Clinical Psychology, 2, 114–121.

Perry, B.D. (1997). The memories of states: How the brain stores and retrieves traumatic experience. In J. Goodwin & R. Attias (Eds.), Splintered reflections: Images of the body in trauma (pp. 9–38). New York: Basic Books.

Perry, B.D., Pollard, R.A., Blakely, T.L., Baker, W.L., & Vigilante, D. (1995). Childhood trauma, the neurobiology of adaptation, and "use dependent" development of the brain: How "states" become "traits." Infant Mental Health Journal, 16, 271–291.

Pynoos, R.S., Frederick, C., Nader, K., Arroyo, W., Sternberg, A., Eth, S., Nunez., F., & Fairbanks, L. (1987). Life threat and posttraumatic stress in school-aged children. Archives of General Psychiatry, 44, 1057–1063.

Pynoos, R.S., Goenjian, A., Tashjian, M., Karakashian, M., Manjikian, R., Manoukian, G., Steinberg, A.M., & Fairbanks, L.A. (1993). Post-traumatic stress reactions in children after the 1988 Armenian earthquake. British Journal of Psychiatry, 163, 239–247.

Sack, W.H., Seeley, J., & Clarke, G. (1997). Does PTSD transcend cultural barriers? A study from the Khmer adolescent refugee project. Journal of the American Academy of Child and Adolescent Psychiatry, 36, 49–54.

Schwarz, E.D., & Kowalski, J.M. (1991). Malignant memories: Posttraumatic stress disorder in children and adults following a school shooting. Journal of the American Academy of Child and Adolescent Psychiatry, 30, 936–944.

Shannon, M.P., Lonigan, C.J., Finch, A.J., & Taylor, C.M. (1994). Children exposed to disaster: I. Epidemiology of post-traumatic symptoms and symptom profiles. Journal of the American Academy of Child and Adolescent Psychiatry, 33, 80–93.
Taylor, S., Kuch, K., Koch, W.J., Crockett, D.J., & Passey, G. (1998). The structure of posttraumatic stress symptoms. Journal of Abnormal Psychology, 107, 154–160.
Vernberg, E.M., & Johnston, C. (2001). Developmental considerations in the use of cognitive therapy for PTSD. Journal of Cognitive Psychotherapy, 15, 223–237.
Vernberg, E.M., La Greca, A.M., Silverman, W.K., & Prinstein, M.J. (1996). Prediction of posttraumatic stress symptoms in children after Hurricane Andrew. Journal of Abnormal Psychology, 105, 237–248.
Vernberg, E.M., & Varela, R.E. (2001). Posttraumatic stress disorder: A developmental perspective. In M.W. Vasey & M.R. Dadds (Eds.), The developmental psychopathology of anxiety (pp. 386–406). New York: Oxford University Press.
Vogel, J.M., & Vernberg, E.M. (1993). Children's psychological responses to disasters. Journal of Clinical Child Psychology, 22, 464–484.
Weathers, F.W., & Litz, B.T. (1993, August). Symptom patterns in combat-related PTSD: Clinical versus community samples. Paper presented at the annual meeting of the American Psychological Association, Toronto.
World Health Organization. (1993). The ICD-10 Classification of Mental and Behavioural Disorders: Diagnostic Criteria for Research. Geneva, Switzerland: Author.