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Do gender and age moderate the symptom structure of PTSD? Findings from a national clinical sample of children and adolescents ☆

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ABSTRACT

A substantial body of evidence documents that the frequency and intensity of posttraumatic stress disorder (PTSD) symptoms are linked to such demographic variables as female sex (e.g., Kaplow et al., 2005) and age (e.g., Meiser-Stedman et al., 2008). Considerably less is known about relations between biological sex and age with PTSD's latent factor structure. This study systematically examined the roles that sex and age may play as candidate moderators of the full range of factor structure parameters of an empirically supported five-factor PTSD model (Elhai et al., 2011). The sample included 6591 trauma-exposed children and adolescents selected from the National Child Traumatic Stress Network's Core Data Set. Confirmatory factor analysis using invariance testing (Gregorich, 2006) and comparative fit index difference values (Cheung and Rensvold, 2002) reflected a mixed pattern of test item intercepts across age groups. The adolescent subsample produced lower residual error variances, reflecting less measurement error than the child subsample. Sex did not show a robust moderating effect. We conclude by discussing implications for clinical assessment, theory building, and future research.

1. Introduction

An emerging line of research suggests that PTSD may be the best conceptualized as consisting of five underlying dimensions (Elhai et al., 2011). Recently those findings have been extended to a national sample of children receiving clinical services (Elhai et al., 2013). Evidence of differences in likelihood and severity of PTSD symptoms in childhood/adolescence by biological sex (Stallard et al., 2004; Kaplow et al., 2005; Laufer and Solomon, 2009; Ditlevsen and Elklit, 2010), and age (Kaplow et al., 2005; Meiser-Stedman et al., 2008; Steinberg et al., 2013) raises the question of whether the structure of PTSD symptoms is invariant despite differences in those demographic/developmental factors. This study systematically tested sex and age as candidate moderators of the latent factor structure of a recently proposed and validated PTSD five-factor model (Elhai et al., 2013) in a national sample of clinic-referred children and adolescents.

1.1. Structural models of PTSD

The traditional *DSM-IV* three-factor conceptualization of PTSD (re-experiencing, avoidance/numbing, and arousal) has failed to receive empirical support through confirmatory factor analysis (CFA) (reviewed in Yufik and Simms, 2010; Elhai and Palmieri, 2011). Thus, better-fitting alternative models varyingly composed of four vs. five latent factors were developed (see Table 1). Among the four-factor models, the *Emotional Numbing Model* (King et al., 1998), and *Dysphoria Model* (Simms et al., 2002) are both well-supported. The four-factor Numbing Model differentiates *avoidance* (C1–C2) from *numbing* (C3–C7) symptoms, but retains the remaining *DSM-IV* clusters. Further, the four-factor Dysphoria Model retains the numbing model's Re-experiencing and Avoidance factors while creating distinct factors (Hyperarousal and

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Table 1
PTSD factor-structure models.

PTSD symptoms	DSM-IV	King et al.	Simms et al.	Five-factor model
B1. Intrusive thoughts	R	R	R	R
B2. Nightmares	R	R	R	R
B3. Reliving traumas	R	R	R	R
B4. Emotional cue reactivity	R	R	R	R
B5. Physiological cue reactivity	R	R	R	R
C1. Avoidance of thoughts	A/N	A	A	A
C2. Avoidance of reminders	A/N	A	A	A
C3. Amnesia for traumatic event	A/N	N	D	N
C4. Loss of interest	A/N	N	D	N
C5. Detachment	A/N	N	D	N
C6. Restricted affect	A/N	N	D	N
C7. Hopelessness	A/N	N	D	N
D1. Sleeping difficulties	H	H	D	DA
D2. Irritability/anger	H	H	D	DA
D3. Concentration difficulties	H	H	D	DA
D4. Hypervigilance	H	H	H	AA
D5. Startled easily	H	H	H	AA

Note: R, reexperiencing; A, avoidance; N, numbing; H, hyperarousal; D, dysphoria; DA, dysphoric arousal; AA, anxious arousal.

Dysphoria) from remaining symptoms. The Hyperarousal Factor has only *DSM-IV* PTSD symptoms D4 and D5; the remaining Criterion D symptoms load on the Dysphoria Factor (which also comprises symptoms C3–C7). Both four-factor models have received support in adults (reviewed in Yufik and Simms, 2010; Elhai and Palmieri, 2011) and more recently in children and adolescents (Elhai et al., 2009; Armour et al., 2011a, 2011b).

In contrast, a recently developed five-factor model distinguishes between Dysphoric Arousal (D1–D3) and Anxious Arousal (D4–D5) factors while retaining the Re-experiencing, Avoidance, and Numbing Factors of the Numbing Model. The rationale for this five-factor model was that items D1–D3 create a different homogeneous factor representing agitated dysphoria (representing more physiological arousal), rather than comprising part of the numbing factor in the Emotional Numbing Model, or part of the Dysphoria Factor in the Dysphoria Model. Thus, the five-factor model addresses the potential distinctiveness of dysphoric arousal by separating those symptoms from the classic PTSD symptoms of anxious arousal. Numbing symptoms relate most strongly to depression, but dysphoric arousal may be involved in both anxiety and mood disorders (Elhai et al., 2011). This more nuanced PTSD structure has received empirical support from multiple recent studies examining differential factor relations with external correlates (Wang et al., 2011a, 2011b). Further supporting the five-factor model, a recent study found that a stronger relation between anxiety symptoms and anxious arousal, and between depression symptoms and dysphoric arousal symptoms (Elhai et al., 2013). The five-factor model also yielded better fit compared to the four-factor models in samples of children and adolescents (Wang et al., 2011a, 2011b, 2012, 2013) as well as adults (Elhai et al., 2011; Armour et al., 2012). Given this growing support for the five-factor model, including evidence of yielding the best fit among models tested in the Core Data Set (Elhai et al., 2013) of the National Child Traumatic Stress Network (NCTSN)—the data set also used in this study—we sought to build on this line of inquiry by evaluating sex and age as candidate sociodemographic moderators. Although many PTSD factor analytic studies have been published, few have rigorously searched for moderating variables (e.g., Simms et al., 2002; Armour et al., 2011b; Wang et al., 2013). Thus, investigating the roles of sex and age as potential moderators of children's PTSD symptoms carries the promise of clarifying the range of applicability and coherence of the five-factor model across different age and gender groups. In turn, the identification of moderating variables can inform efforts to build developmentally appropriate theories and improve methods for treating PTSD in childhood and adolescence.

1.2. Age as a moderator of PTSD factor structure

Few studies have examined age as a moderator of the underlying dimensions of PTSD in children and adolescents (Anthony et al., 1999; Saul et al., 2008). This dearth of literature is especially concerning given the high prevalence of traumatic events (Copeland et al., 2007; Fairbank, 2008) and associated PTSD in these age groups (Bolton et al., 2000; Agustini et al., 2011; Ayer et al., 2011).

There is considerable evidence that PTSD symptom severity varies as a function of age; however the precise nature of this functional relation remains unclear. To date, the child and adolescent literature yields contradictory findings regarding the age–PTSD relationship. One set of studies report higher PTSD symptom scores among pre-adolescents, compared to adolescents (Anthony et al., 1999; Giannopoulou et al., 2006; Kar et al., 2007). A second set of studies report that adolescents have higher PTSD scores than pre-adolescents (Kaplow et al., 2005; Copeland et al., 2007; Ayer et al., 2011). Another study reported higher estimated PTSD prevalence among elementary school-age children than preschoolers following exposure to vehicular accidents (Meiser-Stedman et al., 2008). A third set of studies reports that age is not significantly associated with PTSD severity in adolescents (Bal and Jensen, 2007; Agustini et al., 2011). These conflicting findings may be attributable to a variety of sources, including influences of moderating variables (e.g., Agustini et al., 2011; Trickey et al., 2012), differences in study design and rigor, and developmental differences that exert either risk-inducing or protective effects (Salmon and Bryant, 2002). The inconclusive nature of these findings underscores the need to re-evaluate the relation between age and PTSD using rigorous research methods including CFA.

1.3. Biological sex as a moderator of PTSD factor structure

Overall, females have a higher (approximately two-fold) prevalence for meeting PTSD diagnostic criteria compared to males (e.g., Stallard et al., 2004; Walker et al., 2004; Kaplow et al., 2005; Laufer and Solomon, 2009; Ditlevsen and Elklit, 2010). This sex-linked disparity in PTSD symptom severity (Norris et al., 2002; Ditlevsen and Elklit, 2010; Irish et al., 2011) persists despite evidence of higher trauma exposure among males (e.g., Tolin and Foa, 2006; Breslau and Anthony, 2007). A similar sex-related trend has emerged in children and adolescents; specifically girls endorse a greater frequency/severity of PTSD symptoms than boys (Giannopoulou et al., 2006; Bal and Jensen, 2007; Elklit and Petersen, 2008; Ditlevsen and Elklit, 2010; Agustini et al., 2011).

A number of explanations have been proposed for sex-linked differences in PTSD. Explanations with greater empirical support include sex-linked differences in cognitive appraisals (reviewed in Tolin and Foa, 2002; Olff et al., 2007), psychological (reviewed in Olff et al., 2007) and biological responses to traumatic events (reviewed in Olff et al., 2007; DeSantis et al., 2011), and higher endorsement of *DSM-IV's* A2 criterion in females (Breslau and Kessler, 2001; Peters et al., 2006; Tolin and Foa, 2006). However, few studies (Saul et al., 2008; Armour et al., 2011a) addressing causes of sex-linked differences in PTSD among children/adolescents have used robust statistical procedures such as CFA. Models testing for sex-related links to statistical parameters include the Sack et al. (1997) modified model (Saul et al., 2008), the emotional

numbing model (Armour et al., 2011a; Hall et al., 2012), and the five-factor model (Wang et al., 2013).

1.4. Current study

Accordingly, we address these gaps in the literature by evaluating age and sex as moderators of a full range of statistical parameters constituting the five-factor PTSD model (Elhai et al., 2011) using the UCLA PTSD Reaction Index (PTSD-RI). The sample consists of child and adolescent cases drawn from a large and diverse national network of agencies in the United States that provide mental health services, and is thus substantially different from research samples used in other studies of the factor structure of PTSD (e.g., Anthony et al., 1999; Giannopoulou et al., 2006; Copeland et al., 2007; Kar et al., 2007). Further, the current study used the rigorous model-testing procedure of invariance testing (Gregorich, 2006; Meredith and Teresi, 2006) (described in Section 2.5).

To test age as a candidate moderating variable, we divided subjects into *pre-adolescent* and *adolescent* age groups using 12 years of age as the cut-off point—an age traditionally considered a developmental transition point from pre-pubertal to adolescence (Scheeringa et al., 2006). Besides the dearth of studies assessing the moderating influence of age on PTSD symptoms in a younger sample, prior studies have not assessed invariance of all statistical parameters constituting the five-factor PTSD model. The extant literature offers mixed findings concerning differences in item-level PTSD symptom severity across age groups (e.g., Anthony et al., 1999; Giannopoulou et al., 2006; Ayer et al., 2011). Thus, we systematically tested exploratory questions involving age between-group differences for a full range of structural parameters. These included (numbers in parentheses represent study questions): (1) factor variances, (2) residual error variances (i.e., variance in individual items not accounted for by the common factors), (3) magnitude of respective factor loadings, (4) item intercepts or means, (5) between-factor covariances, and (6) factor means (an index of within-cluster PTSD symptom severity).

Further, to test sex as a candidate moderating variable, based on previous research we hypothesized *a priori* that girls would have significantly higher or greater: (7) item intercepts (reflecting more severe PTSD symptoms) and (8) factor means (Armour et al., 2011a; Wang et al., 2013). Additional exploratory questions centered on testing sex differences in (9) residual error variances, (10) factor variances, (11) between-factor covariances, and (12) invariance of factor loadings across boys and girls without specifying *a priori* any specific pattern of sex-linked differences in factor loadings, given mixed findings in the current literature (Saul et al., 2008; Armour et al., 2011a; Wang et al., 2013).

2. Method

2.1. Participants/procedure

The National Child Traumatic Stress Core Data Set (CDS) consisted of 6635 children and adolescents (ages 7–18 years old) who endorsed at least one traumatic event when presenting for mental health services at one of 56 participating NCTSN sites across the United States (2004–2010). Data-gathering procedures are described elsewhere (Pynoos et al., 2008). Although the result was a convenience sample, the cases came from a wide variety of child and family mental health agencies providing a full range of levels of care with no exclusion criteria other than each program's clinical criteria for admission with a history of trauma exposure.

2.2. Instrumentation

2.2.1. UCLA Trauma History Profile (THP)

The THP derives from the Trauma History Portion of the UCLA PTSD Reaction Index (PTSD-RI) (Steinberg et al., 2004). The THP assesses 20 types of trauma, including exposure to sexual and physical abuse, interpersonal, community, school and domestic violence, serious accidents and medical illness, and natural disasters. Descriptions of traumatic events were adapted from the National Child Abuse and Neglect Data System Glossary (U.S. Department of Health and Human Services Administration for Children and Family, 2002). Clinicians scored traumatic event endorsements as either *occurred* or *suspected to have occurred* based on child, parent or caregiver report and/or documentation from a report filed with police or child protective services.

2.2.2. The UCLA PTSD Reaction Index (PTSD-RI)

The PTSD-RI (Steinberg et al., 2004) is a 22-item self-report questionnaire assessing PTSD symptoms in children and adolescents. Symptoms are rated on a five-point Likert-type frequency scale ranging from 0 (none of the time) to 4 (most of the time) based on the past month. Twenty items reflect the 17 *DSM-IV* PTSD symptoms; two alternative items assess each of *DSM-IV* PTSD Symptoms C6, C7, and D2. We excluded two additional items assessing associated features (fear of recurrence, trauma-related guilt). The PTSD-RI has shown good internal consistency reflected by Cronbach's Alpha values of 0.90 (Steinberg et al., 2013), 0.85 (Ellis et al., 2006) and .87 (Jensen et al., 2009). It has shown good convergent validity (Steinberg et al., 2013) in relation to the Trauma Symptom Checklist for children (Briere, 1996), War Trauma Screening Inventory, and Depression Self-Rating Scale (Ellis et al., 2006). Prior analyses using the PTSD-RI found support for the four-factor models reviewed earlier (Armour et al., 2011a, 2011b). The five-factor model has shown better fit than a four-factor model using the PTSD-RI in the Core Data Set with a mixed sample of trauma-exposed children and adolescents (Elhai et al., 2013).

2.3. Exclusions and treatment of missing data

We excluded 44 participants who had more than 30% (seven or more) PTSD-RI items missing; this ensured sufficient items to inform missing value estimates (Schafer and Graham, 2002; Graham, 2009) (effective sample = 6591). Of the retained participants, 764 were missing 1–6 PTSD-RI items (mostly 1–2 items each). Missing values were estimated using Maximum Likelihood (ML) estimation with Mplus 6.12 software (Muthén and Muthén, 1998–2007).

2.4. Effective sample characteristics

Participants had a mean age of 12.64 years (S.D. = 3.08), with more girls (n = 3657, 55.5%) than boys (n = 2934, 44.5%). Most were Caucasian (n = 3767, 57.2%), or African American (Hispanic/non-Hispanic) (n = 1812, 27.5%); Hispanic ethnicity was reported by 2395 (38.3%). Frequently endorsed traumatic events included traumatic loss/separation/death of loved one (n = 3288, 51.9%), domestic violence (n = 3081, 49.3%), emotional/psychological maltreatment (n = 2249, 37.2%), and physical abuse (n = 1899, 30.4%).

2.5. Analysis

Initial analyses of individual PTSD-RI items using SPSS 17 revealed no violations of the assumption of normality (no skewness or kurtosis values >1.5). Thus, we used ML estimation in subsequent analyses with Mplus 6.12 software (Muthén and Muthén, 1998–2007). We treated PTSD items as continuous variables, using Pearson covariance matrices and linear regression paths for estimating factor loadings.

Three important points should be noted regarding the primary analyses. First, CFA results establishing the current study's baseline model (five-factor model) as the best-fitting model are described in detail elsewhere (Elhai et al., 2013) and are not the central focus of this study. In summary, this model fit well, $\chi^2(157) = 2128.54$, $p < 0.001$, CFI = 0.95, TLI = 0.94, RMSEA = 0.04, SRMR = 0.03, BIC = 419297.49. This model fit significantly better than the three-factor *DSM-IV* model, $\chi^2_{diff}(7) = 1247.84$, $p < 0.001$, the emotional numbing model, $\chi^2_{diff}(4) = 421.32$, $p < 0.001$, and the dysphoria model, $\chi^2_{diff}(4) = 340.57$, $p < 0.001$ (Elhai et al., 2013).

Second, to account for differences in PTSD-RI 20-item vs. *DSM-IV* 17-item PTSD conceptualizations, the two alternative formulations of each of the C6, C7, and D2 items were specified with correlated residual error variances while loading onto their respective factors (three correlated errors in total). Our rationale was based on the construction of the PTSD-RI, which assessed each of these symptoms with a pair of items sharing similar wording in order to provide the best estimate of each symptom—an example of design-driven residuals (Cole et al., 2007).

Third, we conducted two sets of invariance tests, one for the moderating effect of sex (using two groups of male vs. female participants), the other for the moderating effect of age (using two groups of pre-adolescents vs. adolescents). Noteworthy is the dichotomous use of age groups given that invariance testing cannot be used for continuous variables such as age. Invariance testing involves constraining various statistical parameters across independent groups, represented as different models. We began with the least restrictive model (Model A) with subsequent models progressively constraining additional parameters across groups, comparing the more restrictive model to the prior one (with certain exceptions noted below). In Model A, groups were allowed to vary on all parameter estimates,

with item loadings specified according to the five-factor model. Model B constrained factor loadings for each observed item across the groups, testing equivalence of factor loadings (metric/pattern invariance); Model B thus evaluated the cross-group invariance of individual PTSD items. Model C further constrained item intercepts across groups (imposing *scalar* or *strong factorial invariance*) to test endorsed item severity equivalence. Model D constrained residual error variances across groups (imposing strict factorial invariance) to test whether the variance in individual PTSD items is accounted for by the common factors in a consistent manner across groups. In other words, Model D thus tested whether measurement error differed at the item level across groups. The residual errors constrained in Model D did not apply to subsequent tested models (Gregorich, 2006; Meredith and Teresi, 2006). Thus, Model E constrained factor variances and covariances and was tested against Model C, whereas Model F constrained factor means and was tested against Model E. Tests of factor variances and covariances evaluate whether groups differ in the variability within (variances) and interrelationships between (covariances) the latent factors; whereas tests of factor means evaluate whether the groups differ in symptom severity at the level of the latent factors (Gregorich, 2006).

We used χ^2 difference tests to evaluate between-model statistical significance (Models A–F). A significant χ^2 difference indicates non-equivalence (i.e., differences) of the parameter estimate across groups, whereas a non-significant χ^2 difference indicates invariance (i.e., approximate equivalence) (Gregorich, 2006). In light of the tendency of the χ^2 difference test to reach significance in larger samples when only small between-model discrepancies are present (an inherent limitation), we also used the Comparative Fit Index (CFI) as an additional model testing parameter. In general, changes in CFI values smaller than or equal to 0.01 indicate possible invariance of the tested model parameters (Cheung and Rensvold, 2002). The current study thus used the joint decision rules of (1) a significant χ^2 difference test value ($p<0.05$), and (2) a CFI value difference equal/greater than 0.01, to robustly test the non-equivalence of all statistical parameters across sex and age subgroups.

3. Results

3.1. Age as a moderator

Invariance testing evaluated between-group differences in parameter estimates of the five-factor model between the pre-adolescent ($n=3443$) vs. adolescent ($n=3148$) groups (see Tables 2–4). Regarding Exploratory Questions 1 through 4, χ^2 difference tests indicated non-equivalence among many parameter estimates. Specifically, the *adolescent subgroup* had significantly: (1) greater factor variances across four of the five latent factors (except for the Numbing factor); (2) lower residual error variances (with two exceptions: amnesia, and one of the two alternative items assessing restricted affect); and (3) higher factor loadings.

With respect to Exploratory Question (4), patterns for item-level intercept estimates were mixed, with adolescents showing significantly greater PTSD symptom severity for some items, and pre-adolescents showing greater severity for other items. Adolescents showed greater severity on most Re-experiencing factor items Numbing factor items, and Dysphoric Arousal factor items. In contrast, the *pre-adolescent subgroup* showed significantly greater PTSD item severity for the Anxious Arousal Factor than the Avoidance Factor (comprised of two items); each age group endorsed one PTSD item with significantly greater severity. A similar mixed pattern emerged with reference to factor means (Exploratory Question 6): adolescents had higher factor means for Numbing and Dysphoric Arousal, and pre-adolescents had higher factor means for anxious arousal. Last, referencing Exploratory Question 5, the adolescent subgroup had lower between-factor covariances.

The CFI criterion, however, suggested robust non-equivalence only for two parameter estimates—item intercepts and residual error variances, the former with a mixed pattern, and the latter (for the most past) lower in the adolescent subgroup.

3.2. Sex as a moderator

Invariance testing assessed for differences in parameter estimates of the five-factor model between female ($n=3657$) and male ($n=2934$) participants (see Tables 2, 5 and 6). χ^2 significance tests indicated non-equivalence of all parameter estimates; the direction of results was consistent with Hypotheses 7 and 10. Specifically, girls had significantly higher or larger: (7) item intercepts (except for one of the alternative formulations of the irritability item), (8) factor means for all five factors, (9) residual error variance estimates (excluding amnesia, and one of the alternative items assessing restricted affect and irritability), and (10) factor variances (except for the numbing items). Regarding Exploratory Questions 11 and 12, girls had significantly larger factor loadings for most items, and lower factor covariances for most comparisons. However, no sex-related test of model parameters passed the more stringent CFI ≥ 0.01 criterion, the second decision rule for rigorously establishing a robust moderating effect.

4. Discussion

Study results suggested that the five-factor PTSD model was robust across two developmental periods and both biological sexes. Although girls consistently reported higher levels of PTSD symptoms across all five factors, the picture was mixed with regard to age, with children reporting higher levels on some symptoms and adolescents reporting higher levels on other symptoms. Adolescents and girls tended to show greater variability in PTSD symptom factor scores and stronger associations between PTSD symptoms and the putative factors as manifested by factor loadings than children or boys. Results for adolescents and boys showed less evidence of random measurement error than for children or girls. However, findings must be qualified by the added result that neither age nor sex demonstrated a robust moderating effect.

4.1. Age as a moderating variable

Although factorial invariance testing showed evidence that age moderates key parameters of the five-factor PTSD model, only two parameters—item intercepts and residual error variances—were retained after applying the stringent CFI ≥ 0.01 criterion. First, adolescents, compared to pre-adolescents, had significantly lower residual

Table 2
Comparison using age and gender as moderators of the five-factor model parameter estimates (invariance testing).

Model comparisons	χ^2 difference test values (χ^2_{diff})	Degrees of freedom	BIC value difference	CFI value difference
Age				
A vs. B	181.54*	15	−49.634	0.004
B vs. C	415.1*	15	−283.20	0.010
C vs. D	625.14*	20	−449.272	0.014
C vs. E	112.36*	15	19.245	0.002
E vs. F	146.52*	5	−102.552	0.003
Gender				
A vs. B	45.01*	15	86.892	0.001
B vs. C	236.489*	15	−104.586	0.005
C vs. D	87.69*	20	88.182	0.002
C vs. E	84.73*	15	47.17	0.002
E vs. F	238.97*	5	−195.002	0.006

Note: Descriptions of the models are as follows: Model A (all parameters allowed to vary); Model B (constrained factor loadings); Model C (Model B constraints with constrained item-level intercepts); Model D (Model C constraints with constrained residual variances); Model E (Model C constraints with constrained factor variances and covariances); and Model F (Model E constraints with constrained factor means).

* $p<0.001$.

Table 3
Standardized parameter estimates across age groups.

PTSD symptoms	Factor loadings		Item intercepts		Residual error variances	
	Pre-adol	Adol	Pre-adol	Adol	Pre-adol	Adol
Re-experiencing						
B1. Intrusive thoughts	0.662	0.783	1.077	1.085	0.562	0.387
B2. Nightmares	0.634	0.693	1.010	0.950	0.598	0.520
B3. Reliving traumas	0.643	0.692	0.784	0.800	0.587	0.522
B4. Emotional cue reactivity	0.637	0.743	1.390	1.525	0.594	0.448
B5. Physiological cue reactivity	0.696	0.776	1.012	1.085	0.515	0.398
Avoidance						
C1. Avoidance of thoughts	0.601	0.656	1.197	1.377	0.639	0.570
C2. Avoidance of reminders	0.691	0.698	1.011	1.010	0.523	0.513
Numbing						
C3. Amnesia for traumatic event	0.472	0.421	0.849	0.828	0.777	0.823
C4. Loss of interest	0.546	0.650	0.750	0.894	0.702	0.578
C5. Detachment	0.664	0.779	0.813	0.968	0.559	0.394
C6A. Restricted affect	0.601	0.761	0.785	0.919	0.639	0.420
C6B. Restricted affect	0.472	0.350	0.745	0.678	0.778	0.877
C7A. Hopelessness	0.546	0.637	0.641	0.753	0.702	0.594
C7B. Hopelessness	0.601	0.635	0.710	0.828	0.639	0.597
Dysphoric arousal						
D1. Sleeping difficulties	0.611	0.636	1.192	1.167	0.626	0.596
D2A. Irritability/anger	0.532	0.607	1.290	1.479	0.716	0.632
D2B. Irritability/anger	0.491	0.467	1.008	1.146	0.759	0.782
D3. Concentration difficulties	0.581	0.603	1.169	1.372	0.662	0.636
Anxious arousal						
D4. Hypervigilance	0.483	0.543	1.323	1.316	0.767	0.705
D5. Startled easily	0.603	0.635	1.177	1.083	0.637	0.597

Note: Pre-adol (pre-adolescent age group); and adol (adolescent age group).

Table 4
Unstandardized factor variances and standardized covariance estimates across age groups.

PTSD symptoms	Factor variances		Factor covariances	
	Pre-adol	Adol	Pre-adol	Adol
Re-experiencing (R)	0.947	1.183		
Avoidance (A)	0.892	0.992		
Numbing (N)	0.403	0.280		
Dysphoric arousal (DA)	0.889	0.951		
Anxious arousal (AA)	0.526	0.591		
R with A			0.900	0.869
R with N			0.826	0.742
R with DA			0.843	0.761
R with AA			0.803	0.756
A with N			0.776	0.728
A with DA			0.744	0.720
A with AA			0.823	0.761
N with DA			0.884	0.829
N with AA			0.686	0.575
DA with AA			0.770	0.688

Note: Pre-adol (Pre-adolescent age group); and Adol (Adolescent age group).

error variances in general (except amnesia and one item tapping restricted affect), reflecting less unsystematic error in measurement. This finding is consistent with prior research (Anthony et al., 1999) and suggests that PTSD symptoms can be measured more precisely in adolescents than in younger children. One possible explanation is that older youths have a greater ability than younger children to identify and verbalize symptoms (Green et al., 1991). It also is possible that adolescents develop more focal PTSD symptoms as they mature emotionally and intellectually, as opposed to the often diffuse symptoms of distress characterizing younger traumatized children (Briggs-Gowan et al., 2012). Further research is needed to better characterize the shifts in developmental trajectories to measure PTSD more precisely as children grow into adolescents.

Second, adolescents had significantly higher item-level intercept estimates (reflecting more severe within-cluster PTSD symptoms) for three of the five factors. These findings suggested that, compared to children, adolescents report greater symptom severity for most Re-experiencing, Numbing, and Dysphoric Arousal Factors. These results parallel past findings (Green et al., 1991; Copeland et al., 2007; Ayer et al., 2011). Explanations offered for this phenomenon point to adolescents' greater tendency to retain and retrieve discrete memories-a tendency that is attributed in part to adolescents' greater capacity for cognitive understanding of the traumatic event and its consequences, compared to younger children (Green et al., 1991). Alternatively, more severe intrusive and numbing/dysphoria symptoms may reflect adolescents increased risk for traumatic event exposure (e.g., witnessing violence, drug abuse) compared to younger children (Kilpatrick et al., 2003). Consistent with prior findings of greater engagement in externalizing/risky behaviors such as aggressive acts among adolescents (Pynoos et al., 2009; Habib and Labruna, 2011; Scheeringa et al., 2011), our analyses also revealed greater anger/irritability endorsement in the adolescent subgroup.

In contrast, children had higher item intercepts (reflecting greater symptom severity) on the Anxious Arousal Factor which includes hypervigilance and startle reactions. This finding is also consistent with past research (Anthony et al., 1999; Giannopoulou et al., 2006; Kar et al., 2007). Possible explanations for this finding point to pre-adolescents' lower resilience, less effective coping strategies (Kar et al., 2007), greater susceptibility to the influences of parental reactions and traumatization (Green et al., 1991; Giannopoulou et al., 2006), and less mature cognitive/emotional abilities needed to process the trauma

Table 5
Standardized parameter estimates across gender groups.

PTSD symptoms	Factor loadings		Item intercepts		Residual error variances	
	Females	Males	Females	Males	Females	Males
Re-experiencing						
B1. Intrusive thoughts	0.733	0.685	1.182	0.968	0.462	0.531
B2. Nightmares	0.671	0.625	1.066	0.884	0.550	0.609
B3. Reliving traumas	0.685	0.634	0.841	0.730	0.531	0.598
B4. Emotional cue reactivity	0.694	0.658	1.671	1.244	0.518	0.567
B5. Physiological cue reactivity	0.754	0.694	1.182	0.901	0.431	0.518
Avoidance						
C1. Avoidance of thoughts	0.619	0.608	1.436	1.116	0.617	0.631
C2. Avoidance of reminders	0.704	0.667	1.113	0.894	0.504	0.555
Numbing						
C3. Amnesia for traumatic event	0.425	0.463	0.870	0.800	0.819	0.786
C4. Loss of interest	0.626	0.554	0.876	0.747	0.608	0.693
C5. Detachment	0.752	0.666	0.992	0.764	0.434	0.557
C6A. Restricted affect	0.719	0.623	0.923	0.758	0.483	0.611
C6B. Restricted affect	0.408	0.409	0.714	0.707	0.833	0.833
C7A. Hopelessness	0.614	0.566	0.728	0.652	0.623	0.679
C7B. Hopelessness	0.622	0.612	0.805	0.719	0.613	0.625
Dysphoric arousal						
D1. Sleeping difficulties	0.617	0.610	1.264	1.085	0.619	0.628
D2A. Irritability/anger	0.585	0.542	1.455	1.285	0.657	0.706
D2B. Irritability/anger	0.475	0.506	1.063	1.080	0.775	0.744
D3. Concentration difficulties	0.611	0.580	1.276	1.241	0.627	0.664
Anxious arousal						
D4. Hypervigilance	0.528	0.493	1.403	1.222	0.721	0.757
D5. Startled easily	0.629	0.592	1.207	1.042	0.605	0.650

Table 6
Unstandardized factor variances and standardized covariance estimates across gender.

PTSD symptoms	Factor variances		Factor covariances	
	Females	Males	Females	Males
Re-experiencing (R)	1.114	0.921		
Avoidance (A)	0.889	0.882		
Numbing (N)	0.316	0.350		
Dysphoric arousal (DA)	0.892	0.879		
Anxious arousal (AA)	0.572	0.542		
R with A			0.877	0.890
R with N			0.754	0.802
R with DA			0.797	0.801
R with AA			0.779	0.762
A with N			0.711	0.786
A with DA			0.744	0.717
A with AA			0.779	0.797
N with DA			0.861	0.848
N with AA			0.570	0.667
DA with AA			0.716	0.711

(Giannopoulou et al., 2006). Developmental differences between pre-adolescents and adolescents may thus act as either risk or buffering factors and may explain the mixed pattern of item intercepts observed in this study (reviewed in Salmon and Bryant, 2002).

4.2. Biological sex as a moderator

Although our initial tests point to larger factor loadings for girls, no tests of structural equivalence passed the stringent CFI $\geq$ 0.01 criterion. One result, that boys showed higher between-factor covariances, was directly contrary to prior research findings (Armour et al., 2011a; Wang et al., 2013). Overall, it appeared that sex-related differences were not robust and should not be interpreted as providing support for hypotheses of non-equivalence across sexes. As evaluated by the CFI criterion, findings are consistent with epidemiological research suggesting that sex differences in PTSD are relatively limited among adolescents (Kilpatrick et al., 2003) despite becoming substantial in adulthood (Tolin and Foa, 2006). This absence of sex differences may reflect a genuine invariance of the *structure* of PTSD symptoms in childhood and adolescence, despite the general tendency for girls to report higher levels of PTSD symptoms at the item-level (as was found in the current study). Alternately, this absence may reflect the influence of variability in biological or sociocultural gender effects on PTSD symptomatology that may obscure sex differences until youths mature into adulthood.

Our null findings regarding sex are inconsistent with meta-analytic findings of small to moderate effect sizes for sex differences in PTSD severity among children/adolescents (Tolin and Foa, 2006). This inconsistency may be due in part to the influences of moderating variables (e.g., Tolin and Foa, 2006; Elklit and Petersen, 2008; Trickey et al., 2012). Specifically, meta-analytic results suggest that effect sizes for sex differences are smallest in studies utilizing measures of PTSD that are not anchored to a specific index trauma (such as the UCLA PTSD-RI items other than those assessing intrusive re-experiencing)—a practice that may introduce error variance (Tolin and Foa, 2006). An additional moderating variable—whether the trauma is experienced directly or indirectly (not controlled for in this study) significantly influences sex differences (Elklit and Petersen, 2008). In fact, the "other" category of traumatic events (Item 20 in the Trauma History Profile) allowed for endorsement of diverse traumatic events (direct and indirect exposure). Additionally, age of exposure to the index traumatic event is also known to significantly moderate

PTSD sex differences (reviewed in Olff et al., 2007), which was not accounted for in the current study. Lastly, there could be an interaction effect between age and sex that is consistent with a meta-analytic study indicating a greater risk of PTSD in female children when they are older (Trickey et al., 2012).

Although these study results do not discount prior evidence of greater PTSD severity in females (reviewed in Olff et al., 2007), they nevertheless suggest that sex-linked differences in structural parameters of PTSD may not be sufficiently robust to be clinically meaningful in children and adolescents, especially after taking the effects of other potential moderators into account.

4.3. Possible methodological explanations for non-significant findings

Our findings that age moderated only some parameters of PTSD factor structure, and that sex did not moderate PTSD structural parameters to a robust degree, are inconsistent with a considerable body of research reporting the moderating effects of both demographic variables (e.g., Saul et al., 2008; Armour et al., 2011a; Wang et al., 2013). These discrepant results naturally evoke questions regarding what could account for them. We propose five possible explanations: first, the age range in this study sample was wider (adolescents and pre-adolescents) compared to studies such as that of Armour et al. (2011a), Wang et al. (2013), and Saul et al. (2008), which included only adolescents. In particular, Armour et al. (2011a) and Wang et al. (2013) sampled war-exposed Bosnian adolescents and earthquake survivors in China respectively in contrast to the US-based Core Data Set, which covers a diverse spectrum of trauma types across a broad age range. Second, this study used a more rigorous criterion (CFI $\geq$ 0.01) which has not been used in these prior studies. Third, the five-factor model has been tested for invariance in only one known study (Wang et al., 2013). Fourth, the use of a clinic-referred sample in the present study could have produced discrepancies in comparison to past studies conducted with general community samples due to a truncation of PTSD score variability to the moderate-to-severe range. Last, this study used the PTSD-RI in contrast to most prior studies that used other self-report measures.

4.4. Clinical implications

These findings have several implications for clinical practice and theory-building. First, our finding of significantly higher item intercepts in adolescents (except for the Anxious Arousal Factor) suggests that clinic-referred adolescents may report more severe PTSD symptom severity in general compared to younger children—an important developmental consideration for *DSM-5* (Pynoos et al., 2009; Scheeringa et al., 2011). Second, results indicate that simply comparing item-level means across adolescent vs. pre-adolescent age groups when assessing for PTSD severity differences is not sufficiently rigorous to yield theoretically substantive and clinically actionable findings. Rather one needs to consider other differences such as in residual error variances across the age groups. Third, these findings underscore the challenges inherent in assessing PTSD in children, whose test scores (at least as assessed herein) may contain more unsystematic error variance. Fourth, our finding of a lack of substantial moderation by sex on PTSD factor structure underscores the need to take into account the influences of other potentially more robust direct effects and moderators—such as current age, age at trauma exposure, characteristics of traumatic events including dose–response associations, and differential potencies/pathways of specific trauma types (Layne et al., 2010)—when assessing and interpreting sex differences.

4.5. Study limitations, strengths, and further research

Study limitations include the use of PTSD self-report assessments, which may evoke social desirability effects and subjective interpretation of items reducing response accuracy (Furnham, 1986). Noteworthy is that the PTSD-RI items do not conform to the *DSM-IV* PTSD item order in the context of a recent study indicating that the PTSD items response order may be methodologically contributing to the inferior fit of the *DSM-IV* model compared to the four-factor models in adult samples (Marshall et al., 2013). The superior fit of the five-factor model in this study should thus be considered with that caveat. Examining order effects with invariance testing may be an avenue for further research. In addition, we treated age as a dichotomous variable to create two age groups, which may have reduced our ability to capture a more detailed picture of developmentally linked differences in the expression of PTSD across the full range of childhood and adolescence. Last, we used a clinic-referred national sample, which was not nationally representative (restricting generalizability to trauma-exposed youth referred to US-based mental health clinics) and likely reduced variability in PTSD scores by reducing the proportion of low scores in test item distributions. Despite these limitations, the current study included a large geographically diverse national sample, use of a screening test of a broad range of different types of traumatic life events, and the use of rigorous model-testing methods.

Future studies can combine clinician-administered assessments with self-reports measures to better capture potential age and sex-linked differences in PTSD's factor structure. Additionally, factorial invariance testing across groups representing age $\times$ sex interactions would result in increased Type I error and statistical complications. To elaborate, five comparisons per invariance testing for four groups (boys older and younger than 12 years, girls older and younger than 12 years) would result in 30 statistical computations. Future studies can probe for the effects of age $\times$ sex interactions on PTSD item-level and factor severity in light of prior findings (Kessler et al., 1995; Ditlevsen and Elklit, 2010). Additionally, use of longitudinal designs, continuous variables, covariates, more fine-grained age ranges, and a lifespan approach will yield a richer picture of developmentally linked manifestations of PTSD.

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