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The Latent Structure of Posttraumatic Stress Disorder Among Adolescents

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ABSTRACT

Debate has arisen over whether posttraumatic stress disorder (PTSD) is most accurately conceptualized as representing a discrete clinical syndrome or an extreme reaction to traumatic life events. Recent taxometric research using predominately adult samples appears to support a dimensional model of PTSD, raising questions about the utility of current psychiatric nosology which depicts PTSD as a distinct entity. The present study sought to use taxometric procedures to examine the latent structure of posttraumatic stress reactions among a national epidemiologic sample of 2,885 adolescents. Results were consistent with previous taxometric studies in supporting a dimensional model of posttraumatic stress reactions. The implications of these findings for public policy, as well as the etiology and assessment of posttraumatic stress reactions, are discussed.

Since the introduction of Posttraumatic Stress Disorder (PTSD) into the psychiatric nosology in 1980, considerable debate has arisen over whether posttraumatic stress reactions can, in fact, be clearly discriminated as pathological (i.e., PTSD) versus normative. Historically, PTSD has been depicted as a discrete clinical entity that can and should be distinguished from nonpathological traumatic stress reactions. This approach is supported within our current diagnostic system (i.e., *Diagnostic and Statistical Manual of Mental Disorders* [*DSM-IV*], *Fourth Edition*; American Psychiatric Association, 1994), which suggests that individuals who meet specific traumatic event, symptom, duration, and functional impairment criteria are exhibiting a pathological syndrome; whereas individuals who experience similar symptoms but to a lesser extent are exhibiting a normal reaction to extreme stress that does not warrant a diagnostic label. Supporters of the categorical approach have argued that the prevalence, course, and neurobiology of posttraumatic stress reactions support a categorical model (e.g., Yehuda & McFarlane, 1995). However, considerable research has raised questions about the accuracy and utility of the categorical approach to posttraumatic stress and the underlying assumptions it implies.

Evidence to support the dimensional conceptualization of posttraumatic stress reactions has been garnered from several sources. For example, epidemiological studies have indicated that most people will experience some form of traumatic event during their lifetime (Kessler, Sonnega, Bromet,Hughs,&Nelson, 1995; Resnick, Kilpatrick, Dansky, Saunders, & Best, 1993) and, in response, the majority of these individuals experience at least some symptoms of PTSD (Rothbaum, Foa, Riggs, Murdock, & Walsh, 1992). Furthermore, many individuals who experience symptoms of PTSD, but do not meet full*DSM* criteria, report significant impairment in psychosocial and occupational functioning (Marshall et al., 2001), and often display patterns of help-seeking behavior similar to those of individuals who meet full diagnostic criteria (e.g., Stein,Walker, Hazen, & Forde, 1997). The public health and economic significance of subdiagnostic posttraumatic stress reactions is therefore high. These findings raise questions concerning the clarity of the categorical PTSD/no-PTSD distinction and the clinical utility of the current nosological approach.

To meet diagnostic criteria for PTSD, the *DSM-IV* requires that individuals respond to a traumatic event with at least one reexperiencing symptom, three avoidance/numbing symptoms, and two increased arousal symptoms. Although the *DSM* acknowledges that children may display some variation in symptom presentation in comparison with adults (e.g., trauma-specific reenactment or play), symptom frequency and duration criteria remain the same. Yet, accumulating research appears to indicate that developmental factors may play a strong role in determining the quality and pattern of the presentation of posttraumatic stress

symptomatology (e.g., Amaya-Jackson & March, 1995). For example, research has indicated that elementary school age children may not exhibit avoidance or numbing symptoms, but instead may reenact the trauma in their play and drawings (Terr, 1985). Similarly, some evidence suggests that adolescents who have experiencedmultiple or prolonged traumatic events may bemore likely to present with predominately dissociative and externalizing features, including depersonalization, derealization, substance abuse, and aggressive outbursts (Goodwin, 1988; Horowitz, 1996; Terr, 1991). Recent physiological research also suggests that whereas adult trauma survivors generally demonstrate cortisol suppression, adolescents typically do not (Lipschitz et al., 2003). Whether differences in physiological experience and symptom presentation among adolescents and children reflect qualitatively distinct reactions, potentially representing separate causal pathways, or are merely developmentally influenced variations of the same underlying pathology remains unknown. However, such data would have important implications for the diagnosis, assessment, and treatment of adolescents and children with traumatic event histories. One method for evaluating differences in symptom presentation would be to determine whether the latent structure of posttraumatic stress reactions among youth systematically differs from adult responses (Amaya-Jackson & March, 1995; Cohen, 1998).

Taxometrics is a series of mathematical procedures designed specifically to determine whether the latent structures of phenomena are continuous or categorical. Researchers have recently begun to employ taxometric procedures as a means of investigating whether posttraumatic stress reactions are characterized by latent discontinuity (i.e., categorical) or graded dimensionality. To date, taxometric procedures have been applied to several traumatic stress populations, including combat veterans (Forbes, Haslam, Williams, & Creamer, 2005; Ruscio, Ruscio, & Keane, 2002) and adult women (Broman-Fulks et al., 2006). Results of these studies have converged to support a dimensional conceptualization of posttraumatic stress reactions. However, only one of these studies (Broman-Fulks et al., 2006) attempted to examine the latent structure of posttraumatic stress reactions in a sample of youth. Specifically, Broman-Fulks and colleagues (2006) applied three taxometric procedures (MAXEIG, MAMBAC, and L-Mode) to a large nationally representative sample of adolescents. Consistent with research on adult samples, results were supportive of the notion that PTSD does not represent a naturally occurring category (Broman-Fulks, et al., 2006).

Replication is a core feature of the scientific method and is essential for the advancement of science. In the absence of traditional significance testing, taxometric research in particular is heavily dependent on the ability to replicate findings across multiple taxometric procedures and samples (Waller&Meehl, 1998). As

very few studies exist on adolescent PTSD, it is imperative that we determine whether the dimensional findings of prior PTSD taxometric research will indeed replicate in other adolescent samples. Thus, the goal of the present study was to further our understanding of posttraumatic stress reactions among youth by attempting to replicate and extend previous taxometric research in a second national sample of adolescents.

Knowing the latent structure of posttraumatic stress reactions is imperative for several reasons (Meehl, 1992). First, the development and selection of assessment instruments should be consistent with the latent structure of the variable. For dimensional constructs, the goal of assessment measures should be to disperse scores broadly and to discriminate effectively in all areas of the dimension, whereas for taxonic constructs, assessment instruments often attempt to sort individuals at an optimal cut and maximize valid classifications. Second, awareness of latent structure can inform etiological research. Variables with taxonic latent structure generally have a discrete etiological source, such as a particular gene, brain disorder, environmental stressor, or specific interaction of such variables, whereas a dimensional structure implies an additive or graded (i.e., multiply determined) etiology. Finally, artificially dichotomizing a dimensional variable will create an unnatural break in the data and is likely to result in a significant loss of information and statistical power. This last issue would be particularly relevant to public policy makers who often determine service and compensation eligibility based on the presence or absence of a psychiatric diagnosis.

METHOD

Participants

Participants consisted of 2,885 adolescents who completed the 2005 National Survey of Adolescents (NSA-2005), including 1,450 boys (50.3%) and 1,435 girls (49.7%), with a mean age of 14.6 years (*SD* = 1.7). The racial/ethnic breakdown was as follows (data were missing in 99 cases): 1,848 were Caucasian (66.3%), 466 were African American (16.7%), 317 were Hispanic (11.4%), 73wereNative American (2.6%), and 82were Asian (2.9%). Based on their responses to a structured interview, 7.0% of participants met diagnostic criteria for a lifetime history of PTSD. Prevalence of various forms of traumatic events were 8.3% for sexual assault; 16.8% for physical assault; 12.6% for physically abusive punishment; 39.9% for witnessed neighborhood, community, or school violence; and 8.0% for witnessed domestic violence.

Measures

Posttraumatic stress disorder reactions were assessed using the PTSD module of the NSA survey (Kilpatrick, Resnick, Saunders, & Best, 1989), a structured diagnostic interview that assessed each *DSM-IV* criterion with a yes or no response. Research on this PTSD measure has provided support for concurrent validity and several forms of reliability (e.g., temporal stability, internal consistency, diagnostic reliability; Resnick et al., 1993; Ruggiero, Rheingold, Resnick, Kilpatrick, & Galea, 2006). Notably, the NWSPTSD module was validated in a field trial against the PTSD module of the Structured Clinical Interview for the *DSM* (SCID) administered by mental health professionals. The interrater kappa coefficient was 0.85 for the diagnosis of PTSD in the field trial, and comparisons between the NWS-PTSD module and SCID yielded a kappa coefficient of 0.77 (Kilpatrick et al., 1998).

Procedure

Data collection procedures for the NSA-2005 were similar to those used in our previous taxometric study with adolescents (see Broman-Fulks et al., 2006). Participants were selected using amultistage, stratified, random-digit dial procedure within each region of the country; the full sample included a national household probability sample as well as an oversample of urban-dwelling adolescents. During recruitment, 6,694 households were contacted that resulted in both a completed parent interview and identification of at least one eligible adolescent (i.e., defined as an adolescent aged 12–17 years who currently resided in the household or resided in the household for at least 4 months during the year prior to interview). Of these, 1,268 parents (18.9%) refused to allow their adolescent to participate. In 188 additional cases (2.8%), the parent consented but the adolescent refused to be interviewed; and in another 119 (1.8%) cases the adolescent interview was initiated but not completed. Finally, in 1,505 cases (22.5%) parent consent was given and a parent interview was completed but the identified eligible adolescent was unreachable or not available for interview at any of our contacts or callbacks to the family during the field period. The remaining 3,614 cases resulted in completed parent and adolescent interviews. This included 2,459 adolescents in the national cross section and an oversample of 1,155 urban-dwelling adolescents. All adolescents were administered the PTSD module of the structured interview. However, the initial 619 adolescents to complete the interview were administered a slightly modified version of the PTSDmodule.Due to the nature of this study, these adolescents were dropped from analyses. As noted, an additional 110 adolescents were omitted from analyses due to missing data on PTSD items. This resulted in a final study sample of 2,885 youth.

The structured telephone interview (of which the PTSD module was a small component) took about 43 minutes to complete. The interview was administered by trained interviewers employed by SRBI, a survey research firm with significant experience managing survey studies. A computer-assisted telephone interview system aided this process by prompting interviewers with each question consecutively on a computer screen, and supervisors conducted random checks of data entry accuracy and interviewers' adherence to assessment procedures. Consent to participate was obtained from participants and their parents verbally via telephone. Several steps were taken to ensure privacy and integrity of the data (refer to Kilpatrick et al., 2000 for detailed procedural information). All study procedures were approved by the institutional review board at the Medical University of South Carolina.

Indicator Selection

The *DSM-IV* distinguishes between pathological and nonpathological posttraumatic stress reactions on the basis of three symptom clusters: reexperiencing, avoidance/numbing, and hypervigilance. Consistent with this approach, three indicators were created for the present study by summing the items on the NSA-PTSD interview that corresponded with items on each of the three *DSM-IV* symptom clusters. The summation of these items was intended to ensure adequate representation of the full PTSD construct and improve the reliability of the resulting curves. This method is consistent with previous taxometric analyses of PTSD (e.g., Broman-Fulks et al., 2006; Ruscio et al., 2002).

Nuisance covariances, indicator skew, and indicator validities were analyzed to ensure the appropriateness of the indicators for taxometric analysis. Bayes' Theorem was used to separate cases into putative taxon versus nontaxon membership. Taxometric procedures generally work best when nuisance covariances are low (below 0.30) and validities are high (i.e., 1.25 *SD* or greater separation between the two groups). Indicators utilized in the present study had low nuisance covariances (putative taxon group M=0.17 and nontaxon group M=0.22), positive skew (1.86), and were highly valid, with a mean separation of 2.87 *SD* (Range = 2.75 to 3.10). Thus, the indicators were deemed appropriate for taxometric analysis.

Data Analysis

Two taxometric procedures were used to evaluate the latent structure of PTSD: MAXEIG (maximum eigenvalue;Waller &Meehl, 1998) and MAMBAC (mean above minus below a cut; Meehl

& Yonce, 1996). The procedures were run using computer programs obtained from Ruscio (2006) and analyzed using R (R Development Core Team, 2005) statistical software. Below is a brief description of each procedure. A detailed description of these statistical procedures can be found elsewhere (see Ruscio, Haslam, & Ruscio, 2006).

MAXEIG (Waller & Meehl, 1998) is a multivariate procedure that calculates and plots eigenvalues from all remaining indicators across successive intervals of an input indicator. Each indicator serves as the input indicator once, thus generating one MAXEIG plot per indicator. Categorical, or taxonic, data typically yield plots with peaked curves, whereas dimensional data produce relatively flat plots.MAXEIG analyses were run using the inchworm consistency test, with 50, 75, and 100 windows, as an additionalmeasure of consistency.

The MAMBAC (Meehl & Yonce, 1994) procedure is based on the assumption that if two discrete groups exist (i.e., taxon and nontaxon), mean differences between the groups will occur on valid indicators of group membership. MAMBAC functions by calculating and plotting the mean differences of scores on one variable above and below successive cuts on a second variable. Taxonic variables generally yield peaked plots, whereas dimensional variables produce relatively flat or bowl-shaped plots. Taxometric plots were rated as indicative of taxonicity, continuity, or ambiguity by two independent examiners who were experienced with taxometric analyses. The raters were in perfect agreement in their plot ratings. Raters were also given plots generated from simulated taxonic and dimensional data with similar distributional characteristics to aid in the interpretation of the research data plots (Ruscio, 2006).

R E S U L T S

Prior to conducting taxometric analysis of the PTSDdata, suitability of the data for conducting a taxometric analysis was assessed. For data to be considered suitable for taxometric analysis, the simulated taxonic and dimensional data should be clearly discernable from one another (Ruscio, Ruscio, & Meron, 2007). Simulated taxonic data were created by assigning cases to putative taxon and nontaxon groups using the grand mean base rate estimate from each taxometric procedure. Results indicated that the simulated taxonic plots demonstrated clear peaks whereas the simulated dimensional plots did not. Furthermore, the simulated taxonic and dimensional plots could be easily distinguished, indicating that these data were appropriate for taxometric analysis.

The MAXEIG procedure was applied to the three indicators first, producing three plots. None of the plots exhibited a clear peak. Rather, all plots demonstrated a relatively flat line, rising slightly to the right, which is consistent with a latent dimension assessed using indicators with positively skewed distributions. The general shape of the MAXEIG plots did not change with implementation of the ICT (increasing numbers of windows), providing further evidence of a dimensional solution. In comparison with simulated taxonic and dimensional plots, the data plots more closely matched those produced by simulated dimensional data. Figure 1 provides the averaged curves for the MAXEIG and MAMBAC procedures, as well as comparison simulation plots. Figure 2 presents the individual MAXEIG and MAMBAC data plots, including the ICT plots. The Comparison Curve Fit Index (CCFI), which is a numerical gauge of whether the data plots are more consistent with a taxon or dimension, was also examined. The CCFI scores range between 0 and 1, with lower scores (<0.5) being suggestive of a dimensional solution and higher scores (>.5) providing evidence of a taxon. The CCFI for the MAXEIG plots was .20, thereby providing additional support for a dimensional interpretation.

Taxometric procedures require multiple consistency tests to generate convergent evidence before conclusions regarding taxonicity or dimensionality are made. Thus, the data were also submitted to the MAMBAC procedure, generating six MAMBAC plots. None of theMAMBAC plots exhibited peaks that would be expected of a taxon. Furthermore, the data plots closely resembled the dimensional simulations. The CCFI for the MAMBAC plots was .23, providing further evidence for a dimensional PTSD solution. Thus, the collective results of the MAXEIG and MAMBAC procedures converged in support of a latent continuum underlying adolescents' reactions to traumatic events.

D I S C U S S I O N

Current psychiatric nosology regarding dysfunctional stress reactions is implicitly hinged on the assumption that psychological reactions to traumatic events can be categorized as either pathological or nonpathological. However, recent taxometric research appears to be supportive of a continuous rather than categorical conceptualization. The purpose of the present study was to replicate and extend previous research by examining the latent structure of PTSD symptoms among a large representative sample of adolescents. The results provided convergent evidence that PTSD is a dimensional condition among adolescents, thereby complementing the dimensional findings of previous research using adult samples. Thus, accumulating evidence appears to indicate that the diagnosis of PTSD is most accurately conceptualized as a continuous construct across the lifespan.

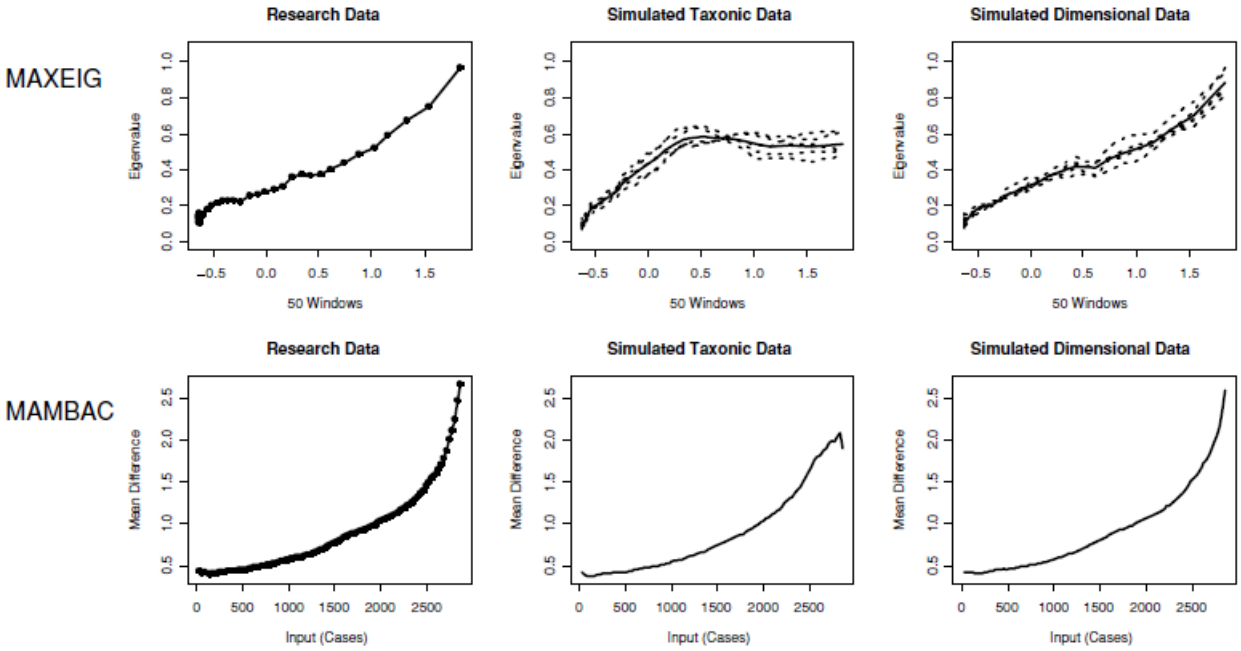

Figure 1. Averaged MAXEIG (top) and MAMBAC (bottom) plots based on NSA-2005 (left), simulated taxonic (middle), and simulated dimensional (right) data.

A dimensional conceptualization of posttrauma reactions has several important implications for our understanding of the psychological effects of traumatic experiences. First, these findings raise concerns regarding the current *DSM-IV* classification system, which implicitly asserts that pathological trauma reactions can and should be distinguished from nonpathological responses. The imposition of a categorical classification system on a continuous PTSDconstruct can have several undesirable effects, including concealing the truly graduated nature of posttraumatic stress reactions and potentially hindering research into the nature, etiology, and measurement of PTSD symptoms. Specifically, dimensional findings are consistent with an additive or graded etiology, thus suggesting that no single environmental or genetic factor is responsible for the development of posttraumatic stress symptoms. In addition, measures of PTSD should be designed to disperse scores broadly and discriminate where along the continuum a particular individual falls rather than attempt to sort individuals into PTSD and sub- or nonclinical PTSD groups. Any dichotomization (e.g., dividing individuals into pathological vs. nonpathological categories) of the PTSD construct will create an unnatural break in the data, thereby limiting construct validity, and leading to an unnecessary loss of information and statistical power. Individuals and organizations should also be wary of using PTSD diagnostic status as the deciding factor for who is eligible to participate in research projects, or more importantly, receive psychological services or monetary compensation. Any such decisions are likely being made

using a threshold that is less than optimal and may be causing many individuals who could benefit from services to not be able to receive such services. Additional research is needed to inform public policy and determine, in the absence of pathological versus nonpathological categorization, how to best identify those individuals who will require psychological and health services following a traumatic event.

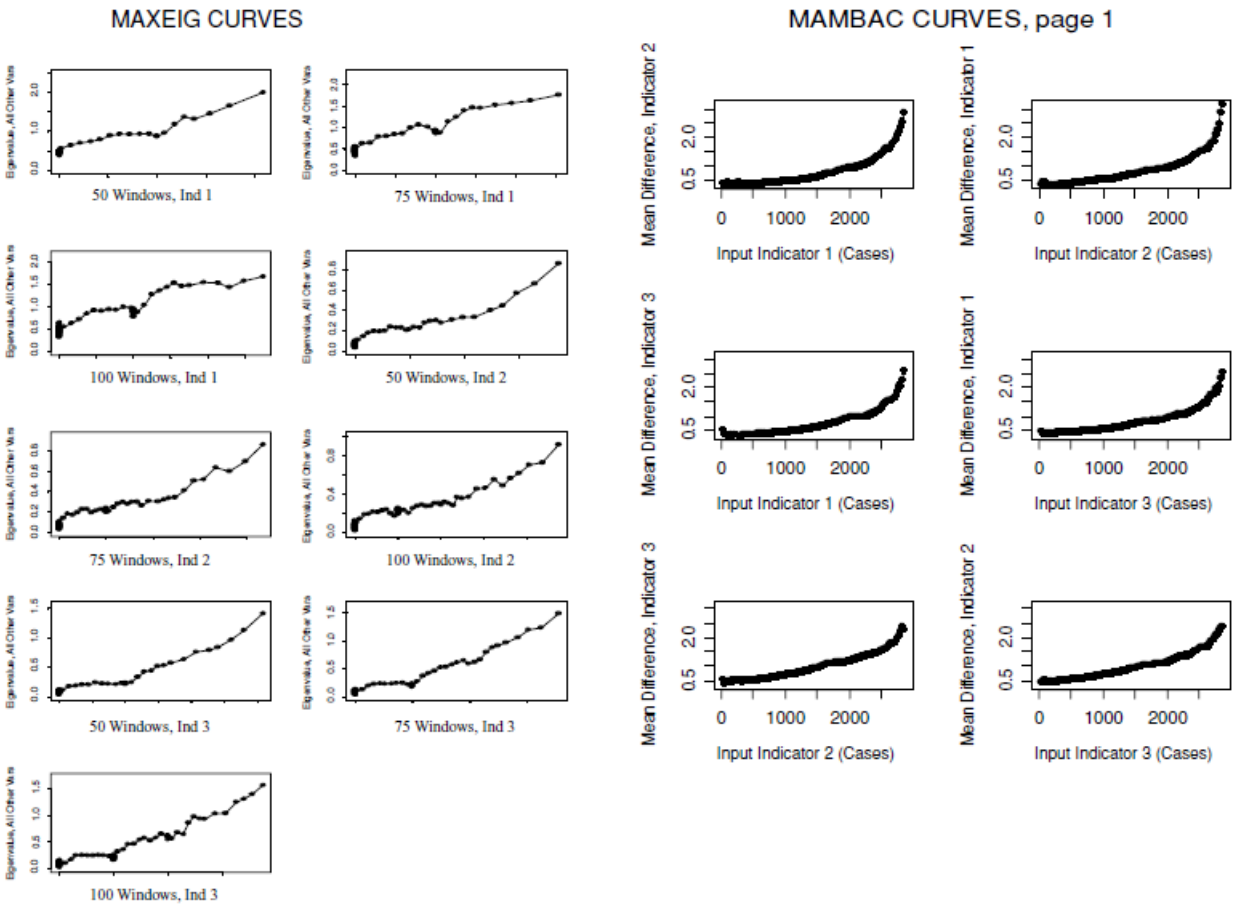

Figure 2. Individual MAXEIG with Inchworm Consistency Test (left) and MAMBAC (right) plots based on NSA-2005 data.

This study has several methodological strengths. These include the large sample size, focus on youth participants, use of a national sample of adolescents, use of a structured diagnostic interview with strong psychometric support, and use of well-established taxometric procedures. However, this study also has limitations. For example, although the indicators used in the present study represent the current *DSM-IV* symptom criteria for PTSD, the indicators did not include items that tend to reflect developmental differences

in symptom presentation among youth. Thus, we can conclude that PTSD, as it is currently defined by the *DSM-IV*, appears to be dimensional at the latent level for both adults and adolescents. However, future research may benefit from the inclusion of indicators that directly assess developmental differences across age ranges. A second potential limitation that deserves mention is that the present research relied on indicators with a relatively restricted range of data points (i.e., 5–7 data points each). Although range restriction can potentially impair the ability of taxometric procedures to uncover latent taxa, several lines of evidence indicate that range restriction was not an issue here. First, an evaluation of the simulated taxonic and dimensional plots that were generated based on the distributional characteristics of the research data reveals that the simulated taxonic plots demonstrated clear peaks, whereas the dimensional plots did not exhibit any such peaks. This suggests that the taxometric procedures should have been able to detect a taxon in the present data had one existed. Furthermore, the indicator validities in the present research were high (*M*=3.17, range = 2.7 to 3.5), and nuisance correlations were low (*Ms* = 0.17 and 0.22 for the hypothetical taxon and nontaxon groups, respectively), providing further evidence for the suitability of these indicators for taxometric analysis. Finally, these indicators replicated those used in previous taxometric research investigating the latent structure of PTSD in other populations (Broman-Fulks, et al., 2006).

The empirical evidence supporting the existence of a PTSD continuum, rather than discrete category, is reflective of an increasing body of research denoting the inadequacy of the current categorical classification system for many forms of psychopathology. Although taxometric research has indicated that some psychological constructs do indeed appear to represent categorical phenomena (e.g., schizotypy; Lenzenweger & Korfine, 1992), many *DSM-IV* diagnoses, including several of the anxiety disorders (e.g., PTSD, social phobia; Kollman, Brown, Liverant, & Hofmann, 2006) appear to be better represented as dimensional phenomena. Thus, the *DSM* classification system is clearly in need of refinement. Taxometric research, with its ability to inform controversies regarding the latent structure of psychopathology, is in a unique position to inform future iterations of the *DSM*. Although taxometrics alone cannot address these issues, and these methods will need to be supplemented (e.g., exploratory factor analysis), it can provide a foundation for such work. Yet, to date, only a few of the hundreds of *DSM* diagnoses have been analyzed from a taxometric perspective, and most studies that have been conducted are still in need of replication. However, the present study, in conjunction with previous taxometric analyses of PTSD, provides consistent and convergent evidence that PTSD is a dimensional, rather than a categorical, phenomenon.

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