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A SYSTEMATIC EVALUATION OF PTSD SYMPTOMS AND COMORBID PSYCHOPATHOLOGY: RESULTS FROM A REPRESENTATIVE SAMPLE OF CHILDREN AND ADOLESCENTS ASSESSED 6 MONTHS AFTER THE 9/11 WORLD TRADE CENTER ATTACK

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ABSTRACT

BACKGROUND. In contrast to the abundant literature on Posttraumatic Stress Disorder (PTSD) in adults, few studies focused on children and adolescents. Ongoing issues in PTSD research in youths are 1) the insufficient specificity of DSM Criterion A, 2) the lack of support for a unique relationship between trauma and PTSD, 3) PTSD phenotypic heterogeneity, 4) the non-specificity of PTSD symptom, 5) the high rates of comorbid disorders, 6) the inclusion of dimensional scaling of PTSD in DSM-V, and 6) differential item functioning of PTSD critieria.

OBJECTIVES. The overall aim of this work is to address these ongoing issues in PTSD research. In particular: 1) to identify specific variables associated with PTSD, 2) to examine if specific variables are differently associated with PTSD and MDD, 3) to explore the role of grief reactions in the development of PTSD and Depression, 4) to examine the heterogeneity of the PTSD syndrome, 5) to examine patterns of comorbidity between PTSD indicators and other psychopathological symptoms, 6) to inform the dimensional scaling of PTSD, and 7) to determine if PTSD indicators display differential item functioning across groups defined by gender and age.

METHODS. Participants and study design: a unique citywide, large, random, representative sample of 8,236 New York City public school students in grades 4 through 12, assessed 6 months following the 9/11 World Trade Ceenter (WYC) attack. Measures: a self-report questionnaire assessing: 1) demographic variables, 2) PTSD, 3) other psychiatric disorders, 4) exposure to the WTC attack (direct, indirect and media exposure), 5) functional impairment, 6) grief reactions, and 7) other variables. Statistical Analysis. Several methods were used, including: 1) multiple correspondence analysis (MCA), 2) multivariate logistic regressions (MLR), 3) latent class analysis (LCA), 4) confirmatory factor analysis (CFA), 5) item response theory (IRT), and 6) differential item functioning (DIF).

RESULTS. MCA. Exploratory analyses with MCA identified axes of variation in psychopathology that guided following analyses. MLR. Different risk factors were associated with PTSD and Depression; however, grief mediated the relationship between loss of a loved one and both PTSD and Depression. LCA. A four-class PTSD model best described PTSD symptom structure; classes differed quantitatively and qualitatively. The latent structure of PTSD varied across empirically defined subgroups characterized by different patterns of exposure, and across subgroups defined by gender and age. LCA on the whole set of psychiatric symptoms yielded a 6-class model as the best fitting one. Three severe disturbance classes were identified, defined by different combinations of internalizing and externalizing symptoms. Classes

varied across groups defined by gender and age. CFA. A one factor model confirmed the unidimensionality of PTSD symptoms. IRT. PTSD criteria show different severity and discrimination parameters that might be usefull for the dimensional scaling of PTSD. DIF. PTSD items function differently in subgroups defined by age and gender.

DISCUSSION. The results are discussed in light of epidemiological and biological findings, and in relation to the ongoing issues in PTSD research. Implications for treatment/prevention of PTSD and for genetic studies of PSTD are provided. Implications for the future edition of the DSM (DSM-V) are discussed as well.

1 BACKGROUND

1.1 Traumatic events and PTSD

Exposure to the trauma of disasters is common. A national survey in the United States suggested that more than 15% of women and 19% of men are exposed to disasters during their lifetime (Kessler et al., 1995). Although the consequences of disasters may include a wide range of psychopathology (Norris et al., 2002), in earlier community studies conducted prior to September 11, 2001 (9/11), it had been shown that posttraumatic stress disorder (PTSD) is the most common type of psychopathology experienced in the aftermath of large-scale traumatic events (Breslau et al., 1998). The disorder involves substantial functional impairment and is often comorbid with other mental health conditions such as depression, generalized anxiety disorder, and substance abuse. For these reasons, PTSD is the most commonly studied mental disorder in the aftermath of disasters (for reviews, see (Galea et al., 2005; Norris et al., 2002).

1.2 PTSD diagnosis

Although PTSD symptoms have been documented for centuries, the American Psychiatric Association officially added PTSD to the third edition of the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM–III*; (APA, 1980) nosologic classification system (Trimble, 1985) only in 1980. The *DSM–III* diagnostic criteria for PTSD were revised in *DSM–III–R* (APA, 1987), *DSM–IV* (APA, 1994), and *DSM–IV–TR* (APA, 2000) and now include exposure to a catastrophic event involving death or injury or threat to one's physical integrity (Criterion A1); a subjective response marked by intense fear, helplessness, or horror (Criterion A2); 17 symptoms in the three symptom clusters of intrusive recollections (Criterion B), avoidant and numbing symptoms (Criterion C), and hyperarousal symptoms (Criterion D); duration of symptoms for at least one month (Criterion E); and functional limitation as a result of symptoms (Criterion F). Large-scale general population studies have supported the *DSM–IV–TR* notion that exposure to trauma precedes the formation of PTSD symptoms, and the estimated lifetime prevalence of PTSD among U.S. adults from these studies is documented at 8% (10% in women, 5% in men), with great variability depending on the type of trauma experienced (Kessler et al., 1995; Kessler et al., 1999).

1.2.1 PTSD screening in epidemiological studies

Research on large-scale traumatic events like 9/11 involves the assessment of exposure (e.g., type, severity, duration), outcomes (e.g., PTSD, depression, complicated grief), and covariates. Although several instruments are designed to assess PTSD after exposure to trauma, there is little consensus with regard to their differential efficacy. PTSD is a clinical condition regularly assessed by clinical interviewers using the SCID (First et al., 1995) or the CAPS (Blake et al., 1995) as gold standards, but researchers in many 9/11 studies used screening instruments for obtaining information about PTSD

symptoms, such as the PCL (Weathers et al., 1993), the Impact of Event Scale (Weiss and Marmar, 1996), the Child PTSD Symptom Scale (Foa et al., 2001), the DPS (Lucas et al., 2001) and the PTSD-RI (Steinberg et al., 2004). Therefore, the results of nonclinical assessments report an approximation of PTSD, that is, probable PTSD. For example, all of the six original community studies on PTSD post-9/11 in adult populations (see below) used symptom checklists to approximate PTSD.

Although most screening instruments showed acceptable psychometric properties, there is no evident agreement in the PTSD literature in general and the 9/11 literature in particular about which screening instrument is most effective in assessing probable PTSD diagnosis. Similarly, there is a lack of consensus on whether face-to-face interviews are needed for a reliable assessment of PTSD or, alternatively, whether telephone- or internet-based surveys are similarly reliable.

Because the majority of the studies on 9/11 had screening measures to assess PTSD, prevalence rates in these studies may have been elevated in relation to studies that used structured diagnostic assessments (e.g., (Brown and Goodman, 2005; Evans et al., 2009; Jayasinghe et al., 2008). However, it is important to consider that the unique constraints of post-disaster research often justify the use of screening instruments that provide high diagnostic efficiency in spite of being less clinically precise.

1.3 Exposure to 9/11 and PTSD in adult populations

1.3.1 Terrorism and Mental Health

Terrorist events by design are traumatic events that erode security and safety. In the last decade, such attacks have increased in sophistication and had enormous impact in terms of loss of life and damage (Bongar, 2006). Although large-scale terrorist acts commonly result in great human and physical destruction, the goal of the attackers, by design, is much broader. Specifically, their aim is to generate fear, terror, intimidation, and mistrust (Comer et al., 2008; Marshall et al., 2007; Neria et al., 2006). When communities are struck by terrorism, the experience is likely to differ from that resulting from natural disasters. Natural disasters are usually limited in time and space and are often expected, therefore enabling coordination of rescue efforts, sheltering, and deployment of medical services. By contrast, terrorism usually occurs randomly and unexpectedly with regard to place and time. These differences can affect psychological outcomes among populations highly exposed to terrorist acts (Norris et al., 2002). In addition, the emotional, social, and political effects of terrorism are likely to be widespread, nonspecific, accumulative, and enduring, and they may affect large communities and influence not just how entire nations cope with the impact of such events but also how they respond to similar threats in the future (Comer et al., 2008).

1.3.2 9/11 and PTSD in the general adult U.S. population

The terrorist attacks on the World Trade Center (WTC) and the Pentagon on the morning of 9/11, have been life changing for many individuals (Neria et al., 2006). Immediately following the attacks, three national studies found widespread posttraumatic stress symptoms in the general U.S. population. Within the first week after 9/11, (Schuster et al., 2001) conducted a national random digit-dial telephone survey of 560 adults and found that 44% of participants reported substantial stress reactions. One to two months after the attacks, (Schlenger et al., 2002) conducted a Web-based study with a nationally representative sample of 2,273 adults and reported a 4.3% prevalence of PTSD that was significantly associated with both the number of hours of television coverage of 9/11 watched and the number of 9/11-related graphic events watched on television. These two studies were followed by a national longitudinal Web-based survey of 2,729 adults conducted by (Silver et al., 2002), who examined demographics, health history, lifetime exposure to stressful events, 9/11 exposures, and coping strategies. In three waves conducted (a) 9–23 days after 9/11, (b) two months after the attacks, and (c) six months after the attacks, the researchers found that within the first month, 12% of individuals reported acute stress symptoms and 8.9% reported symptoms involving functional impairment. The researchers also found that the course of posttraumatic stress symptoms went from 17% at two months to 5.8% at six months post-attack. Taken together, these studies presented initial evidence that the 9/11 attacks, whether proliferated by media images or by concerns about safety in times of war and terrorism, were significantly associated with PTSD symptoms in the general U.S. population.

1.3.3 9/11 and PTSD in New York City

Whereas countless viewers in the United States and worldwide were exposed to the events of 9/11 indirectly, many individuals were highly exposed in the major metropolitan areas of New York City (NYC) and Washington, DC. In NYC alone, the destruction and damage to the WTC Twin Towers and 35 surrounding buildings resulted in almost 3,000 fatalities, 150,000 jobs lost, and $50 billion to $100 billion in economic costs (Bram et al., 2002). After the attacks, the recovery and cleanup period was lengthy, lasting through June 2003. High exposure to the 9/11 attacks in NYC therefore encompassed a myriad of experiences dependent on such factors as one's specific location on 9/11 (i.e., proximity to the WTC), place of residence (i.e., proximity to lower Manhattan), and participation in rescue and recovery efforts. Accordingly, several research groups have reported on 9/11-related PTSD among highly exposed groups.

1.3.3.1 Community studies in adult populations

Six original community studies on PTSD post-9/11 in adult populations have been published within the time frame of September 2001 (following the 9/11 attacks) to April 2011 (Adams and Boscarino, 2006; DiGrande et al., 2008; Galea et al., 2002; Galea et al., 2003; Schlenger et al., 2002; Silver et al., 2002).

Prevalence. In NYC, the initial PTSD prevalence estimates ranged from 11.2% four to eight weeks after the attacks (Schlenger et al., 2002) to (among Manhattan residents only) 7.5% at five to eight weeks post-9/11 (Galea et al., 2002). In a later serial cross-sectional study of NYC residents, the prevalence was estimated to be 2.3% at four months and 1.5% at six months after the attacks (Galea et al., 2003). One year post-9/11, (Silver et al., 2002) found high levels of posttraumatic symptoms in 11.2% of individuals who reported direct exposure to the attacks (e.g., being in the WTC or Pentagon, seeing or hearing the attacks in person, or being close to someone who was in the targeted buildings during the attacks). Comparable levels of PTSD (i.e., 12.6%) were reported by (DiGrande et al., 2008) two to three years after 9/11 among residents living in lower Manhattan. This corroborated the previous finding of (Galea et al., 2002) that in the early wake of the disaster, prevalence of PTSD was 20% among residents living south of Canal Street on 9/11.

Course. In a longitudinal survey representative of adults living in NYC one and two years after 9/11, it was found that the prevalence of PTSD declined from 5% at 12 months after 9/11 to 3.8% at 24 months after 9/11 (rates at both time points were based on the 71% of the baseline sample that was retained at follow-up; (Adams and Boscarino, 2006)). Also, at 24 months post-attack, 3.9% of this sample was identified as having delayed PTSD.

Risk Factors. These studies found that a number of factors significantly increased the risk of PTSD, including demographics such as female gender, young age, and Hispanic ethnicity (Adams and Boscarino, 2006; DiGrande et al., 2008; Galea et al., 2002; Galea et al., 2003; Schlenger et al., 2002); exposure characteristics such as direct exposure (e.g., injury on 9/11, exposure to the dust cloud resulting from tower collapses), proximity to the WTC site (Adams and Boscarino, 2006; DiGrande et al., 2008; Galea et al., 2003), and personally witnessing specific horrific events (e.g., individuals falling from buildings; (DiGrande et al., 2008); experiencing panic attacks during the attacks (as assessed five to eight weeks post-9/11; (Galea et al., 2002); and higher amounts of viewing 9/11-related television coverage on 9/11 and during the few days thereafter (Schlenger et al., 2002). Higher numbers of negative life events during the year before 9/11 were associated with PTSD one year after 9/11, and higher numbers of negative life events experienced after 9/11 were associated with PTSD two years after the attacks. Also, at both one and two years post-9/11, current low self-esteem was found to be associated with PTSD (Adams and Boscarino, 2006).

1.3.3.2 Rescue and recovery workers

Several publications focused exclusively on PTSD in rescue and recovery workers within the first five years after 9/11. Three of these studies reported exclusively on firefighters (Berninger et al., 2010a; Berninger et al., 2010b; Chiu et al., 2011); two reported on disaster relief workers (Cukor et al., 2011; Evans et al., 2006; Evans et al., 2009; Jayasinghe et al., 2008); two reported on utility workers (Cukor et al., 2011; Evans et al., 2009); and two reported on mixed groups of individuals who participated in the rescue, recovery, and/or cleanup operations at the WTC site (Perrin et al., 2007; Stellman et al., 2008). These studies typically involved recruitment of very large samples through either systematic or convenience sampling. Five of these studies used the PCL (Weathers et al., 1993) to approximate PTSD prevalence.

Prevalence. The prevalence of PTSD in rescue and recovery workers (in ascending order of assessment period) was reported as 11.1% at 10 to 61 months after the attacks (Stellman et al., 2008), 5.9% at 17 to 27 months (Evans et al., 2009), 5.8% at 21 to 25 months (Evans et al., 2006), 12.4% at two to three years (Perrin et al., 2007), and 6.8% at three years post-9/11 (Jayasinghe et al., 2008). Among utility workers, prevalence rates of PTSD ranged from 5.9% (Evans et al., 2009) to 8% (Cukor et al., 2011) at 17 to 27 and 10 to 34 months after the attacks, respectively. Among retired firefighters, 22% were found to have symptoms indicative of PTSD four to six years after the attacks (Chiu et al., 2011).

Course. A significant increase in PTSD prevalence was observed in the longitudinal studies of large samples of firefighters conducted by Berninger and colleagues. Specifically, (Berninger et al., 2010b) first reported an increase in PTSD from 8.6% at zero to six months post-9/11 to 11.1% at three to four years post-9/11 (rates for both assessment periods were based on the 83.3% of the baseline sample that was retained at follow-up). A subsequent study by (Berninger et al., 2010b) was conducted on the basis of an expanded version of the same sample studied by (Berninger et al., 2010b), i.e., using less stringent exclusion criteria). The study by (Berninger et al., 2010a) was conducted in four waves and resulted in PTSD rates of 9.8%, 9.9%, 11.7%, and 10.6%, at Years 1, 2, 3, and 4 after the attacks, respectively (of the baseline sample assessed within one year of 9/11, 10.8% was retained at two years, 26.7% was retained at three years, and 40.3% was retained at four years post-9/11). Consistent with these findings, a subset of rescue and recovery workers interviewed as part of the World Trade Center Health Registry (WTCHR) also had a significant increase in PTSD prevalence from 12.1% two to three years post-9/11 to 19.5% five to six years post-9/11 (Brackbill et al., 2009).

Risk factors. Multiple factors were found to significantly increase the risk for PTSD in rescue and recovery workers. Jobs such as construction, engineering, and sanitation were found to be associated with the greatest risk for PTSD, as was being an unaffiliated volunteer (Perrin et al., 2007). Increased exposure by way of working at the WTC site demonstrated significant associations with PTSD (Cukor et al., 2011);

these exposure factors included early arrival to the WTC site and long duration of time worked there (Chiu et al., 2011; Perrin et al., 2007). (Perrin et al., 2007) demonstrated that these factors interacted to increase the risk of PTSD. Loss of a family member or friend in the attacks (Brackbill et al., 2009; Stellman et al., 2008) and 9/11-related job loss, as assessed five to six years post-9/11 (Brackbill et al., 2009), significantly increased risk of PTSD in these populations.

1.3.3.3 WTC evacuees

One study assessed a cohort of civilians who evacuated the WTC Twin Towers on the morning of 9/11 (DiGrande et al., 2011). This study was cross-sectional and approximated PTSD at two to three years post-9/11 using the PCL (Weathers et al., 1993).

Prevalence. This study found that 15% of WTC evacuees met criteria for PTSD (DiGrande et al., 2011).

Risk factors. PTSD was significantly associated with several specific exposures on 9/11, including being on a floor above the plane impact zones, being caught in the dust cloud that resulted from the tower collapses, personally witnessing horror, sustaining an injury, and working for an employer who was killed in the attacks. The strongest association with PTSD was among individuals with lower income two to three years after 9/11: A gradient was observed in which survivors making less than $25,000 per year were eight times more likely to have PTSD than were those earning more than $100,000 per year (rates were 49% and 6%, respectively).

1.3.3.4 NYC workers

In two cross-sectional studies, PTSD was assessed among samples of working individuals in NYC with potential for high exposure to the events of 9/11. (Tapp et al., 2005) used a random sampling method to assess PTSD risk among NYC transit workers seven months post-9/11, whereas (de Bocanegra et al., 2006) used a convenience sample to survey garment workers in the Chinatown neighborhood 28 months post-9/11. In both samples, the PCL (Weathers et al., 1993) was used to approximate PTSD prevalence.

Prevalence. (Tapp et al., 2005) documented a PTSD prevalence of 8% among participants at seven months post-attack. The study by (de Bocanegra et al., 2006) predominantly consisted of women who lost their jobs as a result of 9/11. The prevalence of PTSD among this group was 42% more than two years after 9/11.

Risk factors. Exposures related to the events of 9/11 were found to significantly increase risk of PTSD; these included being in the dust cloud that resulted from the tower collapses and knowing a survivor of the attacks (Tapp et al., 2005). In the Chinatown worker population, PTSD was found to be associated with the post-9/11 variables of seeking care from a physician, indicating a desire to receive counseling, and using prescription medication, all assessed 28 months post-9/11 (de Bocanegra et al., 2006).

1.3.3.5 Primary care patients

Two studies included PTSD findings from cross-sectional surveys conducted between 7 and 16 months post-9/11 (Neria et al., 2006; Neria et al., 2008). One study included findings from longitudinal assessments made approximately one and four years after the attacks (Neria et al., 2010). All studies used the PCL (Weathers et al., 1993) to approximate PTSD.

Prevalence. The prevalence estimate of PTSD in the entire cohort on which these studies were based was 4.7% seven to sixteen months after 9/11 (Neria et al., 2006). A subsample of bereaved individuals who lost someone in the attacks had a higher prevalence of 17.1% (Neria et al., 2008).

Course. In a longitudinal analysis, the prevalence of PTSD was shown to decrease from 9.6% one year after the attacks to 4.1% approximately four years post-9/11; rates at both time points were based on the 46% of the baseline sample that was retained at follow-up (Neria et al., 2010). Most of the respondents with PTSD at baseline (i.e., 89.3%) remitted before follow-up, and most of the PTSD cases at follow-up (i.e., 75%) had late-onset PTSD. Only 1% of the participants met criteria for current PTSD at both time points.

Risk factors. Approximately one year after 9/11, PTSD was associated with Hispanic ethnicity, being born outside of the United States, not being married, pre-9/11 family psychiatric history, and pre-9/11 trauma. In addition, PTSD was found to be associated with a host of current comorbid mental disorders (e.g., depression and anxiety), current impaired functioning, increased current use of mental health medication, assessed 7 to 16 months post-9/11(Neria et al., 2006), and loss of a known person on 9/11 (Neria et al., 2006; Neria et al., 2008). Also, at approximately one and four years after 9/11, PTSD was associated with pre-9/11 major depressive disorder and current impaired functioning. Approximately four years after 9/11, PTSD was associated with current major depressive and anxiety disorders (Neria et al., 2010).

1.3.3.6 Mixed adult samples

Two articles included findings based on over 71,000 individuals enrolled in the WTCHR. The WTCHR included samples of adults highly exposed to the events of 9/11, including building occupants, people on the street or in transit in lower Manhattan on 9/11, local residents, rescue and recovery workers and volunteers, and schoolchildren and staff. Farfel et al. (2008) reported on PTSD in these groups two to three years post-9/11. A longitudinal follow-up was conducted five to six years post-9/11 (Brackbill et al., 2009). The WTCHR was created using mixed methods that included recruitment lists, random digit dialing, and a media campaign. Individuals were assessed for PTSD using the PCL (Weathers et al., 1993).

Prevalence. The overall prevalence of PTSD among WTCHR participants was first reported at 16.3% two to three years after 9/11 (Farfel et al., 2008). The prevalence was highest (i.e., 19%) among building occupants and people on the street or in transit in lower Manhattan on 9/11.

Course. Brackbill et al. (2009) found a significant increase in PTSD from 14.3% two to three years post-9/11 to 19.1% four to five years post-9/11. Rates for both assessment periods were based on a subsample (N=43,032) of a larger sample in which asthma symptoms were assessed (N=46,322); in the full sample, 68.1% of the baseline sample was retained at follow-up. In this time range, the greatest increase in PTSD occurred among rescue and recovery workers (12.1% to 19.5%). Building occupants and people on the street or in transit in lower Manhattan on 9/11 continued to have the highest prevalence of PTSD at follow-up (i.e., 23.2% at four to five years post-9/11).

Risk factors. Demographic factors such as Hispanic ethnicity and household income below $25,000 (assessed two to three years post-9/11) increased risk of PTSD. Specific exposures on 9/11 were also strongly associated with PTSD; these included being in the dust cloud that resulted from the tower collapses and sustaining injury. Other correlates of PTSD were evacuation time and time of return home or to work after 9/11 (Farfel et al., 2008). Evacuees who had not returned to live or work in lower Manhattan by two to three years after the attacks had the highest prevalence of PTSD (Farfel et al., 2008). In the longitudinal assessment, 9/11 exposures were strongly associated with long-term PTSD risk; these included intense dust cloud exposure, injury, and personally witnessing horror. However, post-event experiences of 9/11-related job loss and low social support (assessed five to six years post-9/11) were the strongest risk factors (Brackbill et al., 2009).

1.4 Exposure to 9/11 and PTSD in children and adolescents

Research conducted in the past decade and summarized above demonstrates that the burden of 9/11-related PTSD in adult samples is substantial in both the short and the long term. In contrast to the abundant literature on 9/11-related PTSD in adults, few studies focused on children and adolescents. Findings on the psychological effects of 9/11 on children and adolescents are summarized below.

Prevalence. In four- to seven-year-old NYC children, PTSD prevalence was estimated at 18% four to five months post-9/11 (Fairbrother et al., 2003). In NYC schoolchildren in Grades 4 through 12, PTSD prevalence was assessed six months after 9/11 and estimated at 10.6% by (Hoven et al., 2005b)); (Rosen and Cohen, 2010) estimated that PTSD prevalence ranged from 7.4% to 26.8% in this population of schoolchildren six months post-9/11. Approximately 10 months after the attacks, prevalence of PTSD was estimated at 14% in younger children up to age 5 years (DeVoe et al., 2011) and at 20.4% in children who experienced the death of a parent because of the attacks (Rosen and Cohen, 2010). A very high PTSD prevalence of 35% was found in a sample of Chinatown schoolchildren living near Ground Zero two and a half years after 9/11 (Mullett-Hume et al., 2008).

Course. In a small-scale longitudinal study of children whose parents were killed in the 9/11 attacks, PTSD prevalence was 29.6% at four months and gradually declined to approximately 5% two years after the attacks. Retention was not reported for this sample of participants, who entered the study at various points in time (Pfeffer et al., 2007).

Risk factors. Risk factors for 9/11-related PTSD in four- to seven-year-old NYC children four to five months after the attacks included current 9/11-related parental PTSD, a parent crying in front of a child after 9/11, seeing three or more graphic images of the attacks on television on 9/11 and during the first week thereafter, and being a Manhattan resident. All variables were assessed in parent interviews (Fairbrother et al., 2003). In NYC schoolchildren in Grades 4 to 12, risk factors for 9/11-related PTSD six months post-event included higher exposure to the events of 9/11, female gender, lower grade level, exposure of a family member, and higher numbers of pre-9/11 traumatic experiences, all reported by the schoolchildren (Hoven et al., 2005b). Current hypothalamic–pituitary–adrenal (HPA) axis dysregulation (as assessed at six-month intervals between four months and two years post-9/11) was shown to be a risk factor for 9/11-related PTSD in children who experienced the death of a parent because of the WTC attacks (Pfeffer et al., 2007).

1.5 The New York City Department of Education study (NYC-DES)

Hoven and colleagues (2005) conducted the only population-based survey of New York City in the early aftermath of 9/11. Six months post-9/11, a representative sample of 8,236 public schoolchildren (Grades 4–12) in 94 public schools was surveyed about exposure to the disaster, pre-9/11 trauma, and post-9/11 adjustment. Eight probable mental disorders were assessed: PTSD, major depression, generalized anxiety disorder, separation anxiety disorder, panic, agoraphobia, conduct disorder, and alcohol problems. This study provides the data for all the results outlined in this work (see "Methods" for more detailed information). The original study of Hoven et al. (2005) has 6 main findings.

First, 6 months after 9/11, a high proportion of NYC public school children had a probable mental disorder. A projected 205 000 students (28.6%) in grades 4 through 12 had 1 or more of the 6 probable anxiety/depressive disorders.

The second main finding is that the severity of exposure to 9/11 was related to the likelihood of having 1 or more of the 8 probable disorders assessed. Generally, among children with neither direct nor family exposure to the WTC attack, the prevalence of these probable disorders was not elevated and appeared quite similar in magnitude to previous community studies. Based on the association between increased prevalence and greater exposure, it appears that the elevated prevalence of probable PTSD, as well as the other probable anxiety and depressive disorders, is related to exposure to the WTC attack. This observation must be made with caution, as pre-event prevalence in the same population is not available. The higher prevalence of probable alcohol abuse/dependence and conduct disorder among the most

severely exposed compared with those less exposed may also be related to the WTC attack. However, because these probable disorders do not exhibit as clear an association with dose of exposure, the present study cannot be considered as providing strong evidence for such a relationship.

The third main finding was that a wide range of probable mental disorders was elevated, in addition to PTSD. The variety of probable disorders identified by this survey highlights the importance of comprehensive population-based screening for psychiatric problems in children after a major disaster.

The fourth main finding was that family exposure to the WTC attack was associated with probable mental disorder, even more strongly than direct exposure. This suggests that some children may experience greater emotional impact from having a family member exposed than from being directly exposed themselves.

The fifth main finding was that going to a school near the place of the attack was associated with lower rates of probable mental disorder. This somewhat surprising finding may possibly be explained by a combination of factors, such as worldwide attention to their situation, increased social support, and the fact that students in the ground zero area schools were the recipients of significant mental health intervention immediately after 9/11. Although the following characteristics did not explain lower risk of psychopathology when added to multiple logistic regression models, students sampled from the ground zero area schools were more likely to be Asian, on average older, more likely to have received mental health services, and to live in households with 2 parents than were NYC students in general. However, while the complete explanation remains unclear, the broad geographic distribution of children with probable mental disorders throughout NYC indicates that those in need of mental health intervention after this disaster were not confined to the immediate area of the attack.

The sixth main finding was that exposure to trauma prior to the WTC attack was a major risk factor for a post-9/11 probable mental disorder. Thinking prospectively, this finding is of considerable public health significance since a significant proportion of NYC children have now experienced a major trauma (9/11), rendering them more vulnerable to mental disorders in the future, especially following any new disaster.

1.6 Controversies and challenges in PTSD research in children

The DSM makes several age-related comments about specific PTSD criteria, with notes added about different manifestations of signs and symptoms in Criteria A2, B1, B2, and B3. Nevertheless, DSM-IV criteria for PTSD were developed from and field tested on adult samples: no individuals 15 years of age or younger were included (Scheeringa and Haslett, 2010). Moreover, DSM-IV is often used as the basis to assign PTSD diagnoses to individuals younger than 15, but the same diagnostic algorithm is used for all ages. In fact, until recently, there were few data available about the symptomatology of children less than 18 years old and almost no data on the symptomatology of children less than 12 years who have been

traumatized. In this general context, other more specific controversies and challenges in PTSD research in children are outlined below.

1.6.1 Criterion A1 and A2; Insufficient specificity of Criterion A ('Criterion creep' hypothesis)

In the DSM-IV the definition of a traumatic stressor was broadened so that a person who is not personally and directly exposed to trauma but rather learns about someone else being traumatized now qualifies as having been exposed to trauma. As a result, critics have charged that there is a kind of "conceptual bracket creep" or "criterion creep" that is causing PTSD to be diagnosed in response to situations that are far removed from the original concept of a trauma (Brewin et al., 2009). Importantly, (Breslau and Kessler, 2001) found that the broadening of the stressor criterion in DSM-IV did lead to more cases of PTSD, but that most were attributable to learning about the sudden unexpected death of a close relative or friend, an event that could quite reasonably be described as traumatic.

(Kilpatrick et al., 2009) tested the hypothesis that a nonrestrictive definition would substantially increase PTSD prevalence (as predicted by the bracket creep hypothesis) in large probability samples of adolescents in Florida. The authors first determined the total number of PTSD cases that existed defined as meeting B, C, D, E, and F criteria and then determined the proportion of cases that were attributable to Potentially Traumatic Events (PTEs; i.e., Criterion A1 only), traumatic events (i.e., Criteria A1 and A2), and other stressor events. Few PTSD cases occurred in the absence of Criterion A1 events, providing little support for the criterion creep hypothesis. It should be noted that failure to assess any type of PTEs would increase the likelihood of finding support for the criterion creep hypothesis because these unmeasured events could be responsible for cases of PTSD not attributable to the non-measured PTEs. Kilpatrick et al. (2009) also suggest placing greater emphasis on Criterion F (Impairment). Careful assessment of the extent to which PTSD symptoms produce high levels of distress and/or functional impairment in a person's life is the best way to make sure that a PTSD case, as opposed to the event that produced it, is not trivial.

However, the A1 criterion in children has not generated the same degree of controversy as in the adult literature (Pynoos et al., 2009). PTSD begins with an initial moment of panic or sense of being suddenly overwhelmed by an uncontrollable, desperate situation. The challenge with children oftentimes is determining what was frightening, because their perceptions of experiences may differ from adults due to their relative dependence and smaller physical size. For example, many children say that their "worst" or most frightening moment was not when traumatic events occurred (e.g., when the planes crashed on the twin towers), but when trauma-related events occurred (e.g., seeing their parent cry after a trauma). Children and many young adolescents are dependent on parents or other primary caregivers physically and emotionally, and more importantly, for safety. Parents provide children's primary protection from real

or perceived danger; thus, children's and young adolescent's perception of danger and safety is often influenced by the needs of the parent-child relationship (Scheeringa and Haslett, 2010).

When a child suddenly loses a parent (e.g., through death during the WTC attack), this event do not in itself meet the life-threatening criterion. Nevertheless, there may be discrete events within those larger traumas in which children perceived serious threats to safety and possibly to psychological or physical survival. Several studies not related to 9/11 have shown that traumatic death of a parent or other close relative has been shown to lead to significant PTSD symptoms in several studies of children aged 6–17, even if the parent was abusive or neglectful (see Scheeringa et al. (2010) for review). In a representative community sample, Costello et al. found that so-called "low magnitude" events (which included deaths or losses) were both more common and more likely to lead to PTSD in children than "high magnitude" events, such as child abuse or accidents (Costello et al., 2002). Thus, regarding criterion A1, Scheeringa et al. (2010) in their recent influential paper suggested to consider including loss, injury, or death of parent, or significant other as potentially traumatic events.

Another issue related to Criterion A is that multiple trauma exposure and/or early chronic trauma exposure are not addressed in DSM-IV. Approximately half of trauma-exposed children experience more than one type of trauma (Copeland 2007). DSM-IV requires that symptoms be linked to "the trauma". Asking children to link current DSM symptoms to a specific trauma may pose challenges in conditions of chronic or repeated traumas. The text description in DSM-IV could be revised to heighten awareness of this common feature.

Regarding criterion A2, it is common for children and young adolescents to report a variety of feelings other than fear, helplessness, or horror. For example, children might report being "confused", "sad", or "frozen" and/or experience feelings such as hame, guilt, or disgust (Pynoos et al., 2009). In addition, traumatized children and young adolescents may not be willing or able to describe how they felt during the traumatic event. Finally, children and youth who have experienced chronic and/or multiple traumas may report that they are "numb" during traumatic events (Scheeringa and Haslett, 2010). Thus, Scheeringa et al. (2010) argued that it might be optimal to drop the A2 criterion for school age children and adolescents. If retained, the authors suggest that it should be broadened to include additional emotional reactions, to encompass the primary types of feelings expressed by traumatized children during their traumatic experiences or to omit this criterion.

1.6.2 Other disorders are linked to traumatic (Criterion A) events

The existence of DSM-IV Criterion A in the diagnosis of PTSD implies a unique relationship between trauma and PTSD (Brewin et al., 2009). However, the psychological consequences of the 9/11 attacks (and of traumatic events in general) have not been limited to PTSD. A considerable body of research conducted in the first 10 years after 9/11 has shown that other mental health problems have developed in

association with the WTC attacks, such as depression and complicated grief, among others (Neria et al., 2011). However, this research has been conducted almost exclusively in adults, with the exception of the study by Hoven and colleagues (2005) (see "The New York City Department of Education study", and "Participants and Study Design").

1.6.2.1 Major Depressive Disorder (MDD)

In several studies, major depression was found to be one of the most prevalent conditions occurring concurrently with PTSD following exposure to a traumatic event (O'Donnell et al., 2004). A number of studies in adults have focused on MDD after the 9/11 attacks in the NYC area. Estimates of the prevalence of MDD have ranged from 9.7% five to eight weeks after the attacks (Galea et al., 2002) to 12.4% within the first six months after 9/11 (Ahern et al., 2002). In a study of adult primary care patients seeking treatment in a large primary care setting in northern Manhattan (Neria et al., 2008), 29.2% of patients who reported knowing someone who died due to the 9/11 attacks also reported experiencing depression one year after 9/11. These findings seem not to support the unique relationship between exposure to trauma and PTSD established in the DSM.

Furthermore, many risk factors, such as a history of depression, event severity, childhood abuse, and female gender, are risk factors for both PTSD and major depression (O'Donnell et al., 2004) (Copeland 2007). If PTSD and depression are, indeed, separate constructs, traumatic events should increase the risk for PTSD independently of MDD, and viceversa. Even if traumatic events were not found to be associated with either disorder independently of the presence of the other disorder, PTSD and MDD could be considered as two separate conditions if they had their own set of risk factors. Regrettably, no studies in children and adolescents have addressed these issues. There is evidence in adult populations and in relation to events other than 9/11, that traumatic events do not increase the risk for other disorders independently of the increased risk for PTSD; Breslau et al. (2000) showed that that there was an increased risk for depression in respondents who had also developed PTSD, but no increased risk in respondents who were exposed to trauma without developing PTSD (Breslau et al., 2000b).

1.6.2.2 Complicated Grief (CG)

Although sudden traumatic loss is known to be a risk factor for a range of psychopathology, including PTSD (Neria and Litz, 2004; Norris et al., 2002a; Norris et al., 2002b), CG may be its most prominent outcome. CG is considered to be more severe than normal grief, commonly marked by prolonged yearning for the deceased, bitterness, interpersonal disengagement, and a sense of meaninglessness (Prigerson and Maciejewski, 2008). It is found to be associated with considerable functional impairment, physical and mental health morbidity, lost productivity, suicide, and fewer quality-adjusted life years (Lichtenthal et al., 2004). Symptoms of CG and PTSD may co-occur in the event of traumatic loss (Neria

and Litz, 2004), but avoidance of fear-inducing stimuli associated with psychic trauma does not occur with CG after a natural death. Rather, there is an excessive focus on the loss and reminders of the deceased, a desire for reconnection with the deceased, and, in most cases, comfort and/or longing (as opposed to aversive physiological reactivity) when exposed to symbolic cues that conjure thoughts of the deceased (Neria and Litz, 2004). CG is particularly important to study in the context of 9/11, because loved ones have been lost suddenly, horrifically, and unexpectedly. After the attacks of 9/11, Neria and colleagues found that 43% of a sample of 707 adults who lost a loved one screened positive for CG two and a half to three and a half years after the terrorist event (Neria et al., 2007). Similarly, in a smaller sample (N = 149) of those who lost loved ones and were assessed about 18 months after 9/11, Shear et al found that 44% screened positive for CG. These findings underscore the painful, often debilitating, and enduring consequences of traumatic loss in the context of mass violence events (Shear et al., 2006).

1.6.3 Phenotypic heterogeneity

Like for many psychiatric disorders, the use of multiple symptoms to diagnose PTSD leads to heterogeneity in the manifestation of the syndrome (Breslau et al., 2005). Furthermore, as shown above, several PTSD defining symptoms (e.g., difficulty falling or staying asleep) are not only likely to be experienced by patients affected by other psychiatric disorders, but are part of the criteria for other mental disorders as well. Thus, it has been suggested that PTSD diagnostic criteria should not retain symptoms that are part of the diagnostic criteria for other mood and anxiety disorders (irritability, insomnia, difficulty concentrating, and markedly diminished interest) (Spitzer et al., 2007). However, as pointed out by Chung and Breslau, even though single PTSD defining symptoms are non-specific, what constitutes PTSD as a specific syndrome is the way symptoms combine with each other and the relation with a traumatic memory (Chung and Breslau, 2008).

Factors such as age, gender and the nature of traumatic exposure might all contribute to the heterogeneous clinical presentation of PTSD and influence the configuration of PTSD symptoms. Since no individuals 15 years of age or younger were included in the development of PTSD DSM-IV criteria (Scheeringa and Haslett, 2010), PTSD criteria might not be developmentally sensitive enough to detect the manifestations of the PTSD syndrome in childhood and early to mid-adolescence. Several authors have recently stressed the need for DSM-V to incorporate developmental considerations into diagnostic criteria for PTSD, taking into account age-related differences in its manifestations (Roussos et al., 2005b; Scheeringa and Haslett, 2010). Every disorder in DSM-V, not only PTSD, will be refined with developmentally informed diagnostic criteria (Scheeringa and Haslett, 2010). In addition to age and developmental phase, gender and trauma-related factors, such as the nature of the traumatic exposure, may play an important role in the manifestation of PTSD, especially in children and adolescents. Female gender consistently emerges as a risk factor for PTSD, also in young populations (Breslau et al., 1991; Breslau et al., 1997a; Breslau et al.,

2000a; Breslau et al., 1998; Copeland et al., 2007b; Cuffe et al., 1998; Goenjian et al., 1994; Goenjian et al., 2008; Goenjian et al., 2005; Kessler et al., 1995; La Greca et al., 1996a; Nemeroff et al., 2006). Differences between gender groups could be in part related to differential risk for developing posttraumatic symptoms (Lonigan et al., 1994; Olff et al., 2007; Shannon et al., 1994) (Shannon et al., 1994). Quantitative and qualitative differences in PTSD symptom profiles across genders in children and adolescents have not been explored before. Finally, as described in studies of adults, there is evidence suggesting that different forms of traumatic experiences are associated with differential risk for developing PTSD (Pine and Cohen, 2002; Pynoos et al., 2009b) as well as different forms of psychopathology (Eley et al., 2003; Eley and Stevenson, 2000; Kendler et al., 2003; Pine et al., 2005). Thus, different 9/11-related traumatic experiences (eg, direct exposure vs. indirect exposure) and consequences (eg, being physically hurt vs losing a loved one) might be differently associated with PTSD severity and configuration.

The heterogeneity of the PTSD clinical syndrome has led to the examination of the underlying structure of the observable PTSD symptoms (Breslau et al., 2005). PTSD symptom structure in adult and adolescent samples has been mainly investigated through factor analytic methods (Ayer et al., 2011a; Elhai et al., 2009; Ford et al., 2009; King et al., 1998; Sack et al., 1997; Saul et al., 2008; Shevlin et al., 2009; Simms et al., 2002). However, factor analysis is not suited to address the issue of heterogeneity in the manifestation of the disorder (Ayer et al., 2011b). Latent class analysis (LCA) provides an alternative statistical framework used to explore the underlying relationships among multivariate categorical data based on individual's similar symptom profiles. Breslau and colleagues were the first to examine the latent structure of PTSD with LCA in a sample of trauma-exposed participants with a wide age range (18-45 years) (Breslau et al., 2005) and in a sample of trauma-exposed White and African American young adults (19 – 23 years of age) (Chung and Breslau, 2008). The authors identified three discrete classes of individuals, grouped based on a severity gradient of disturbance: pervasive, intermediate and no disturbance. In addition, the findings showed evidence of a qualitative difference of PTSD configuration, with the prominence of emotional numbing symptoms among participants categorized as having pervasive disturbance. Recently, Ayer and colleagues applied LCA to 1,119 trauma-exposed youths aged 12 through 17, assessed at two waves with telephone interviews (Ayer et al., 2011). Similar to findings in adult populations, the authors replicated the evidence of 3-class structure of adolescent PTSD at each time point. Importantly, the PTSD severity-distinguishing symptoms identified at Wave 2 were different from the ones identified at Wave 1 and were not characterized by the numbing cluster, contrary to the findings of Breslau and colleagues in adults. These results suggest that one year during adolescence is enough time to observe changes in PTSD severity-distinguishing symptoms and therefore in PTSD latent structure, emphasizing the importance of a developmental approach to assessment and treatment of PTSD.

Furthermore, a substantial percentage of adolescents who had the severe symptom profile did not fulfill DSM-IV criteria to be diagnosed with PTSD. As pointed out by the authors, this evidence further suggests that symptom configuration and the presence of specific symptoms, rather than only the number of symptoms, may better describe PTSD severity and be more informative for diagnosis and treatment in young individuals (Ayer et al., 2011).

1.6.4 Non-specificity of PTSD symptom (overlap with other disorders).

Many PTSD symptoms (e.g., difficulty concentrating, difficulty sleeping, diminished interest in activities) are common in other psychiatric disorders, such as Major Depression; furthermore, several PTSD symptoms are part of the criteria for other mental disorders as well (e.g., difficulty concentrating is in the diagnostic criteria for both Major Depressive Disorder and Generalized Anxiety Disorder). To address this problem, Spitzer and colleagues (Spitzer et al., 2007) proposed to evaluate the B, C, and D symptoms of PTSD in terms of their diagnostic specificity, to differentiate PTSD from other mood and anxiety disorders, and proposed to retain only symptoms related to exposure to a severe trauma. According to the authors, even though the definitive list of such symptoms needs to be derived from the results of empirical study, from a face validity perspective, the criteria sets should, wherever possible, not include items that are part of the diagnostic criteria for other mood and anxiety disorders. Thus, irritability (PTSD_RI item E3), insomnia (DPS item D2; PTSD_RI item E5), difficulty concentrating (DPS item D8; PTSD_RI item E6), and markedly diminished interest would be eliminated from the PTSD criteria, allowing for the remaining symptoms in Criterion C and D to be combined into a single symptom list (Spitzer et al., 2007).

1.6.5 Comorbidity

An issue related to the previous one is that PTSD is often comorbid with other psychiatric disorders. Psychiatric disorders co-occur in patterns that constitute classes, or spectra, of psychopathology. Recent factor analytic studies of the structure of comorbidity suggest that the covariation of the most common mental disorders can be accounted for primarily by two broad dimensions termed *externalizing* and *internalizing*. Externalizing is a latent dimension of psychopathology that explains the covariation observed in adults between substance-related and antisocial personality disorders (e.g., (Krueger, 1999; Krueger et al., 1998; Krueger et al., 2001) and in children between the co-occurrence of conduct disorder, oppositional defiant disorder, and attention deficit hyperactivity disorder (Coolidge et al., 2001; Dick et al., 2005). Internalizing is the latent factor that underlies the co-occurrence of the anxiety and unipolar mood disorders (Krueger, 1999), which are also known as the "emotional disorders" (Watson, 2005). In several studies, internalizing has been subdivided into correlated factors termed "anxious-misery" (defined by major depression, dysthymia, generalized anxiety disorder) and "fear", comprised of panic

and phobic disorders (Cox et al., 2002; Krueger, 1999; Slade and Watson, 2006; Vollebergh et al., 2001). These factors are thought to constitute essential components of the structure of mental illness and have been proposed to form part of a meta-structure for DSM-V according to the common factors underlying classes of related disorders.

Recent studies that have examined the location of PTSD within this taxonomy have raised questions about the classification of PTSD as an anxiety disorder and have implications for where the diagnosis should be located in DSM-V. Together, results of these studies suggest that PTSD may share more common variance with disorders defined by anhedonic mood and anxious rumination than with those characterized primarily by pathological fear (e.g., panic disorder and phobias) or externalizing behaviors (Resick and Miller, 2009). Interestingly, the previously mentioned findings of Breslau and Kessler (2001) show that the increase in PTSD rates attributable to the broadening of Criterion A1 in DSM-IV occurred mainly because of events consisting of learning of unexpected injury to or the death of a close friend or loved one. These events are as likely to have induced sadness and grief as fear or horror. It is possible therefore that it is related conditions such as depression, also characterized by intrusive memories and general symptoms of dysphoria, that account for the apparent increase in PTSD rates that has been reported with the broadening of Criterion A1.

However, findings from studies on the temporal order of development of PTSD and its comorbidities suggest that PTSD might not belong with the anxious-misery disorders in DSM-V. Disorders within the same spectrum, thought to arise from a common vulnerability, should be equally likely to precede each other in order of temporal development (e.g., the likelihood of disorder A preceding disorder B should be roughly equivalent to the likelihood of disorder B preceding disorder A). This does not appear to be true for PTSD where studies of new-onset cases suggest that PTSD exerts a causal influence on most co-occurring disorders, including those of the anxious-misery spectrum with which it is most strongly related. Several studies (see (Resick and Miller, 2009) have shown that new-onset psychopathology that develops in the wake of trauma rarely precedes or develops in the absence of PTSD. This implies a causal influence of PTSD on comorbid psychopathology and suggests a distinct phenomenology, which should be reflected in its diagnostic class membership within DSM.

Another principle of psychopathology that should have bearing on the location of PTSD in DSM-V is developmental continuity, i.e., the notion that adult psychopathology tends to be foreshadowed by childhood and/or adolescent problems in the same domain. Evidence shows that many adults with anxiety disorders report histories of juvenile anxiety disorders, but they do not typically report juvenile externalizing disorders. The exception to this is found among samples of individuals with PTSD where adult patients frequently have histories of childhood externalizing disorders. For example, (Gregory et al., 2007) examined data from a large prospective longitudinal study (N =1,037) spanning the ages of 11 to 32

and used follow-back analyses to determine the history of juvenile disorders (i.e., occurring between ages 11–15) in 32-year-old adults with anxiety disorders. Results showed that while adults with most types of anxiety disorders other than PTSD had histories of juvenile internalizing disorders only, approximately 50% of cases with PTSD also had histories of juvenile conduct disorder or oppositional defiant disorder.

Results of twin studies are consistent with these findings and suggest that PTSD shares genetic influences with both internalizing and externalizing spectrum diagnoses, including juvenile conduct disorder (Koenen et al., 2005a) and substance dependence (Koenen et al., 2005b). Recently, investigators modeled the genetic and environmental architecture of latent internalizing and externalizing dimensions of comorbidity and the relationship of PTSD to each dimension using diagnostic data from 3,372 male–male twin pairs who served in the military during the Vietnam Era (Wolf et al., 2009). Results showed that while PTSD covaried more strongly with disorders of the internalizing spectrum, it also evidenced a significant relationship with the externalizing latent factor defined also by antisocial personality disorder, drug abuse/dependence, and alcohol/abuse dependence. These findings, and those reviewed previously, suggest that PTSD may arise as a function of latent liabilities towards either internalizing or externalizing psychopathology. This proposition is consistent also with recent studies of personality-based subtypes of PTSD, which have shown that many adults with PTSD exhibit a predominantly externalizing pattern of comorbidity characterized by problems in the domain of impulse–control, antisociality, and substance abuse (Miller et al., 2003; Miller et al., 2004; Miller and Resick, 2007).

Thus, fear and anxiety are neither the exclusive nor predominant emotions associated with the development and maintenance of PTSD. Results of comorbidity studies raise further concern about conceptualizing PTSD simply as the manifestation of a vulnerability to anxiety-related psychopathology (Resick and Miller, 2009). Resick and Miller (2009) conceptualize PTSD as the product of an environmental pathogen (i.e., a serious adverse life event) operating on individual diatheses that span the spectrum of human variation in vulnerability to psychopathology. This diathesis-stress interaction results in extensive population heterogeneity in the clinical expression of posttraumatic psychopathology, pathological anxiety being just one manifestation of this interaction. To better reflect this, Resick and Miller (2009) propose that PTSD be located in DSM-V among a class of disorders defined by the causal conditional nature of their relationship to serious adverse life events, i.e., a spectrum of traumatic stress disorders. This new class would include the existing diagnoses of PTSD, acute stress disorder, and adjustment disorder.

According to Resick and Miller (2009), consideration should also be given to including "complex PTSD," a complicated or traumatic grief disorder, and clinically significant trauma-related externalizing reactions not currently captured by any existing diagnostic category. Diagnoses in this class should differ qualitatively from one another and from disorders described elsewhere in DSM-V with decisions

regarding the inclusion of a given diagnosis based on evidence for its discriminant validity, clinical utility, and clear relationship to a precipitating life event. Resick and Miller (2009) believe that this new class of disorders might better capture the heterogeneity of psychiatric disturbances that are manifested in response to serious adverse life events. These considerations are particularly relevant for children and adolescents, since, as a consequence of trauma, older children may be propelled into greater independence and misjudgments about danger and protective action that can result in reckless or high-risk behaviors; in addition, the neural signature of achieving safety engages the reward centers of the brain that are also involved in substance abuse and thrill-seeking behavior, an especially relevant consideration in regard to adolescents and young adults (Pynoos et al., 2009). Furthermore, the field of child traumatic stress has paid particular attention to the combined effects of trauma and loss exposure for 2 reasons: (1) children and adolescents are at risk for the loss of parents, siblings, and peers through violence, injury, and catastrophic medical events at which they are often present; (2) there is a significant interplay between PTSD and traumatic grief reactions observed in traumatically bereaved child and adolescent populations. The accompanying text in DSM-V needs to alert clinicians to the compounding effect of trauma and loss (Pynoos et al., 2009).

1.6.6 Dimensional scaling and differential item functioning of PTSD symptoms

Using factor analytic approaches, surprisingly no studies have explored the factor structure underlying PTSD across gender, age and different exposures. However, even if empirically derived factor structures invariance across demographic and exposures was demonstrated, factor structure equivalence does not imply scalar equivalence, which holds when scores represent the same levels of a construct across diverse populations, as criterion mean scores are typically ignored in factor analysis (Saha et al., 2006). As previously stated, researchers have recently taken an exploratory approach to identifying subtypes of individuals with similar PTSD symptom profiles using LCA. In LCA, which uses categorical latent variables, the latent classes ignore possible within-class heterogeneity, such as individual differences in severity. For this reason, among others, subtypes of PTSD emerging from LCA studies might not be distinguished by unique profiles or classes but rather by their placement along a continuum of severity. Although the search for discrete subtypes or distinct profiles of PTSD has yielded evidence for a continuum of severity, no research has applied modern dimensional psychometric methods to inform conceptualizations of PTSD.

In an attempt to overcome this limitation, researchers from numerous perspectives have begun to gravitate towards item response theory (IRT) (Lord, 1968). Unlike factor analytic techniques, IRT can characterize differences in criterion functioning in a way that does not depend on differences in the distribution of the latent construct (i.e. PTSD) across groups being compared (Saha et al., 2006). The revision of the diagnostic definitions of psychiatric disorders in DSM-V will most likely include dimensional scaling of

disorders, in addition to the categorical scaling used in the current system (Gelhorn et al., 2009). Dimensional scaling refers to the use of symptom criteria to indicate the severity of disorder on a continuous scale, which, when compared with diagnostic categories, allows for flexibility in cutoff points for different social and clinical decisions and may provide more information on disorder severity. Surprisingly, there has been little research on the extent to which the current criteria are appropriate for diagnostic categories or dimensional scaling. IRT can be used to address this question. Many researchers have conducted IRT analyses on DSM disorders such as depression (Aggen et al., 2005), bulimia (Rowe et al., 2002), substance use (Kirisci et al., 2006; Martin et al., 2006; Saha et al., 2006), anxiety and mood disorders (Krueger and Finger, 2001), and Conduct Disorder (Gelhorn et al., 2009). No previous studies have applied IRT to PTSD symptoms.

IRT is attractive because it allows for characterization of individual item properties, dimensional scaling of the severity of traits, and can facilitate comparisons of latent trait estimates across measures with common criteria (e.g., two different screening questionnaires for PTSD). Instead of examining only symptom count data, IRT uses additional information provided by symptom endorsement patterns because it directly models individual diagnostic criteria (Bock et al., 1988). Sets of diagnostic criteria in DSM-IV are not intended to completely describe the behavioral abnormalities of patients. Instead, they should concretely represent important aspects of those abnormalities, so that the number of criteria met by a patient reflects the severity of that patient's disorder. However, this approach doesn't take into account the fact that one criterion (i.e., a symptom) might reflect greater severity than another. For example, two children may be similarly classified as having PTSD, one because she/he has recurrent and intrusive distressing recollections of the event (a very common symptom following traumatic exposure), and the other because she/he feels as if the traumatic event were recurring, with illusions, hallucinations, and dissociative flashback episodes. With IRT, information regarding the severity of disorder in each patient can be obtained by examining the specific symptoms each patient endorsed.

IRT is useful for examining psychopathology for at least three reasons. First, it allows one to examine the extent to which the current diagnostic symptom criteria indicate the dimensional severity of patients' behavioral abnormalities. For example, IRT can evaluate whether certain criteria are informative only at extreme severity levels of pathology or if they are useful for scaling severity across a wide range of pathology. Second, IRT can provide additional information about the implications of current diagnostic threshold cutoff points by characterizing the levels of psychopathology in the community. Third, IRT allows for the examination of specific properties of individual symptom criteria to test which criteria significantly indicate psychopathology and to identify the level of severity of psychopathology at which the criteria are most informative. Thus, one can statistically compare the criteria across groups (e.g., male subjects, female subjects) to examine whether the symptom criteria function consistently. The

determination of differential item functioning (DIF) across groups is important because criteria that exhibit DIF are of questionable validity and may represent bias in the assessment of PTSD. Moreover, the presence of DIF indicates that the odds of endorsing a particular criterion are not invariant across groups.

To date, no studies have applied IRT to examine the possibility of a posttraumatic reaction continuum in which multiple PTSD indicators map to a broad dimension of severity. To determine whether PTSD symptoms measure a unitary dimension of severity, large representative general population samples are needed. More importantly, large sample sizes are required to capitalize on IRT methodology to examine whether each criterion function differently among subtypes of the general population defined in terms of sex and age, in a manner independent of the distribution of the construct across these groups. It is important to examine psychiatric diagnostic criteria in large community samples because they may provide information that cannot be obtained solely from studies of clinical samples. Despite lower prevalence of pathology in community samples compared with clinical samples, clinical samples may contain bias because of differences in willingness, resources, or ability to seek treatment; greater severity of pathology; or an excess proportion of patients with comorbid disorders compared with community samples. Also, sex differences observed within or across clinical samples may be due to either true differences in the patterns of behavior across sex or, alternatively, to the different recruiting biases for male and female subjects (Gelhorn et al., 2009).

2 OBJECTIVES

The overall aim of this work is to address the controversies and challenges in PTSD research using a unique citywide, large, random, representative sample of 8,236 New York City public school students in grades 4 through 12, assessed 6 months following the 9/11 WTC attack.

2.1 A. To identify specific variables associated with PTSD

Exploiting the large sample size available, broad 9/11-related direct, family and media exposure variables were disaggregated into their component parts; the same procedure was followed for other covariates. The aim is to identify specific variables associated with PTSD (e.g., to see the planes crash), as opposed to broad or summary variables like the ones analyzed in the original study (Hoven et al., 2005b) (e.g., severe direct exposure). This is more relevant in PTSD prevention and intervention, because in real life clinical setting patients report on specific traumatic experiences (e.g., "to see the plane crashing on the tower was terrifying") and not on summary variables. If specific events or variables are more strongly related to PTSD, preventive efforts could be more focused and target specific groups with specific characteristics.

2.2 B. To examine if specific variables are differently associated with PTSD and MDD

PTSD is the only disorder for which diagnostic criteria require previous exposure to a traumatic event (Criterion A). This requirement implies a unique relationship between trauma and PTSD (Brewin et al., 2009). However, several studies conducted after 9/11 have shown that other mental health problems have developed in association with the WTC attacks. MDD is used as an example to examine if the unique relationship between trauma and PTSD established by the DSM-IV is justified, or if other disorders (MDD in this case) are similarly associated with traumatic exposure.

2.3 C. To explore the role of grief as a mediator between death of a loved one and PTSD/MDD

Sudden traumatic loss is known to be a risk factor for PTSD, MDD, and for complicated grief in particular. Furthermore, complicated grief is strongly linked to PTSD and MDD. Therefore, it was hypothesized that complicated grief could mediate the relationship between death of a loved one and PTSD, and between death of a loved one and MDD.

2.4 D. To examine the heterogeneity of PTSD syndrome

PTSD symptom structure was examined across different age groups, gender and traumatic experiences. Differences related to age, gender and traumatic exposure in the way PTSD symptoms combine with each other to produce a clinically relevant disturbance could potentially help explaining and predicting how maturational dynamics in neurobiology, cognition, and self-regulation might influence the manifestation of PTSD, and therefore inform PTSD treatment and prevention.

2.5 E. To examine patterns of comorbidity between PTSD indicators and other psychopathological symptoms

The structure PTSD symptoms and other psychopathological symptoms was examined in the whole sample and in subgroups defined by age and gender.

2.6 F. To determine whether PTSD indicators display differential item functioning across sex and age

IRT was used to examine the DSM-IV PTSD symptom criteria in a community sample of adolescents, to assess the suitability of the criteria in facilitating dimensional scaling of PTSD, and to test for sex and age differences in the criteria. More specifically, IRT methodology was used 1) to examine the ability of PTSD symptoms to discriminate between individuals across the posttraumatic stress reaction continuum, 2) to determine the differential severity of PTSD criteria, and 3) to identify a subset of PTSD criteria that conveyed the most information along the entire continuum. In addition, the large sample size of the NYC-DES allowed for the examination of DIF across important sex and age subgroups of the population.

3 METHODS

3.1 Participants and study design

Children and adolescents (N=8,236), ages 9-21 were assessed six months after September 11, 2001. More than 1.1 million students in grades kindergarten through 12 were enrolled in New York City public schools at the time of assessment. The sampling plan targeted the universe (excluding special education schools) of New York City public school students enrolled in grades 4 through 12 (estimated to be approximately 716 189 youth when the sampling plan was carried out) 6 months after September 11, 2001.

Each of the 1193 New York City public schools was first assigned to 1 of 3 sampling strata (Figure 1). Stratum 1, the ground zero area, comprised 15 elementary, middle, and high schools located in the immediate vicinity of the WTC. Stratum 2, high-risk areas, included schools whose students could be at elevated risk because of family exposure, geography, or other events. This stratum consisted of other schools in Manhattan below 14th Street; schools in Brooklyn along the East River facing the WTC; schools in Staten Island where a disproportionate number of police, fire, and emergency workers live; schools in Belle Harbor, Queens, where American Airlines flight 587 to the Dominican Republic crashed on November 12, 2001; and schools in Washington Heights, where more than 85 500 Dominican Republic expatriates reside, as well as the relatives of many of those who died on flight 587. The purpose of this stratum was to oversample high risk populations in order to make sure that specific groups would be adequately represented in the final sample. Stratum 3 comprised the schools in all other New York City areas. Mainstreamed special education students were eligible for selection.

Schools were sampled separately in each of the 3 strata (Figure 2). In the ground zero area stratum, all eligible schools were invited to participate. In the high-risk (oversampled) and other areas strata, each school was weighted according to the number of eligible students, and schools were then selected with probability proportional to size. A total of 102 schools were targeted: 15 ground zero area, 28 high risk, and 59 other area. A total of 94 schools participated. Six refusals were in ground zero area schools (most not wanting to perpetuate a focus on September 11). Participating and nonparticipating ground zero area schools did not differ in proximity to the WTC, but all of the schools with large enrollments participated. Nonparticipating schools enrolled younger elementary school–aged students.

Participating ground zero area schools (primarily high schools) drew most (82%) of their student bodies from outside the immediate geographical area, whereas the nonparticipating ground zero area schools (primarily elementary schools) enrolled local populations. In strata 2 and 3, 3 classrooms were randomly selected in each school, while in the ground zero area all eligible schools were selected and the method was simple random selection of classrooms (Figure 2).

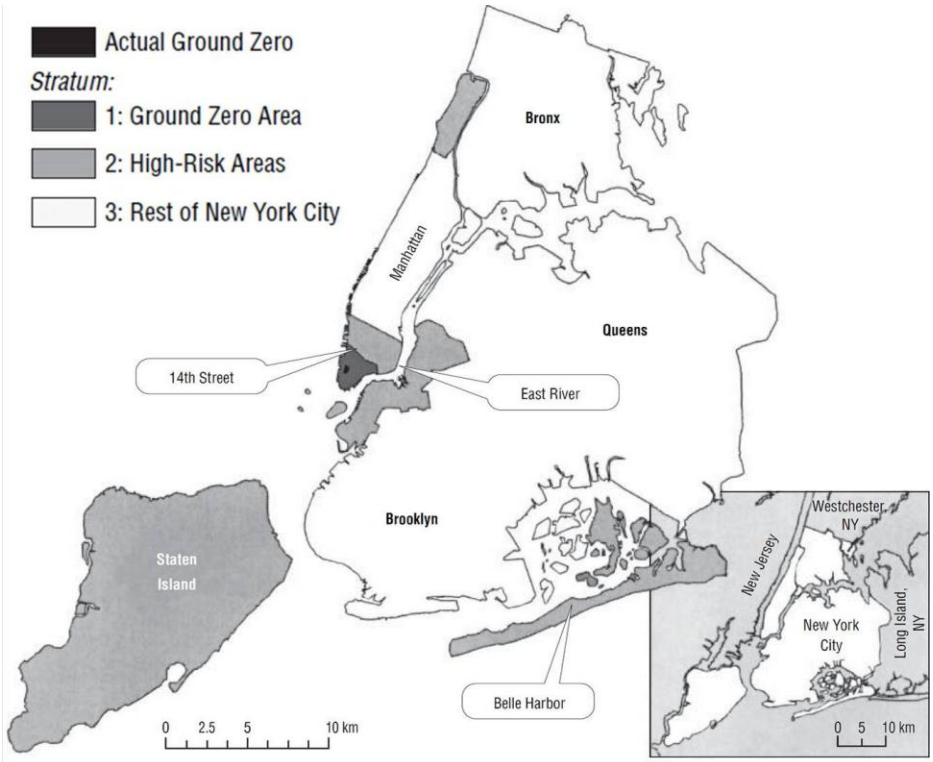

Figure 1. New York City Department of Education Study survey strata.

In each stratum, all students in selected classrooms were solicited for recruitment. Among 10 469 eligible students, 667 parents or students refused participation prior to data collection and an additional 217 students refused participation on the day of data collection. Of the 10 469 eligible students, 1326 (11%) were absent on the day of the survey, a rate identical to that reported by the New York City Department of Education among 4th through 12th graders in 2001-2002. By grade, compliance ranged from 69.02% among 4th and 5th graders (64.97%, including absentees) to 95.83% among 6th through 8th graders (87.24%, including absentees). The lowest compliance rate by both stratum and grade was 59.05% among 4th and 5th graders in the ground zero area stratum (57.94%, including absentees). The final sample consisted of 8236 students aged 9 to 21 years.

To maximize the range of information obtained while not exceeding the allotted administration time, a planned missing data 3-form design (Graham et al., 1996; Schafer and Graham, 2002) was used. Each questionnaire consisted of a core, as well as 2 of 3 possible non-core sections. Hence, each student received the core and two thirds of the noncore questionnaire.

3.2 Measures and Procedures

A self-report questionnaire was administered to the children. Each questionnaire consisted of a core (e.g., demographics, exposure, PTSD, etc.), as well as two out of three possible non-core sections. This procedure - a planned missing data three-form design (Graham et al., 1996; Schafer and Graham, 2002) -

aimed to maximize the range of information obtained, within the fixed administration time available (one class period).

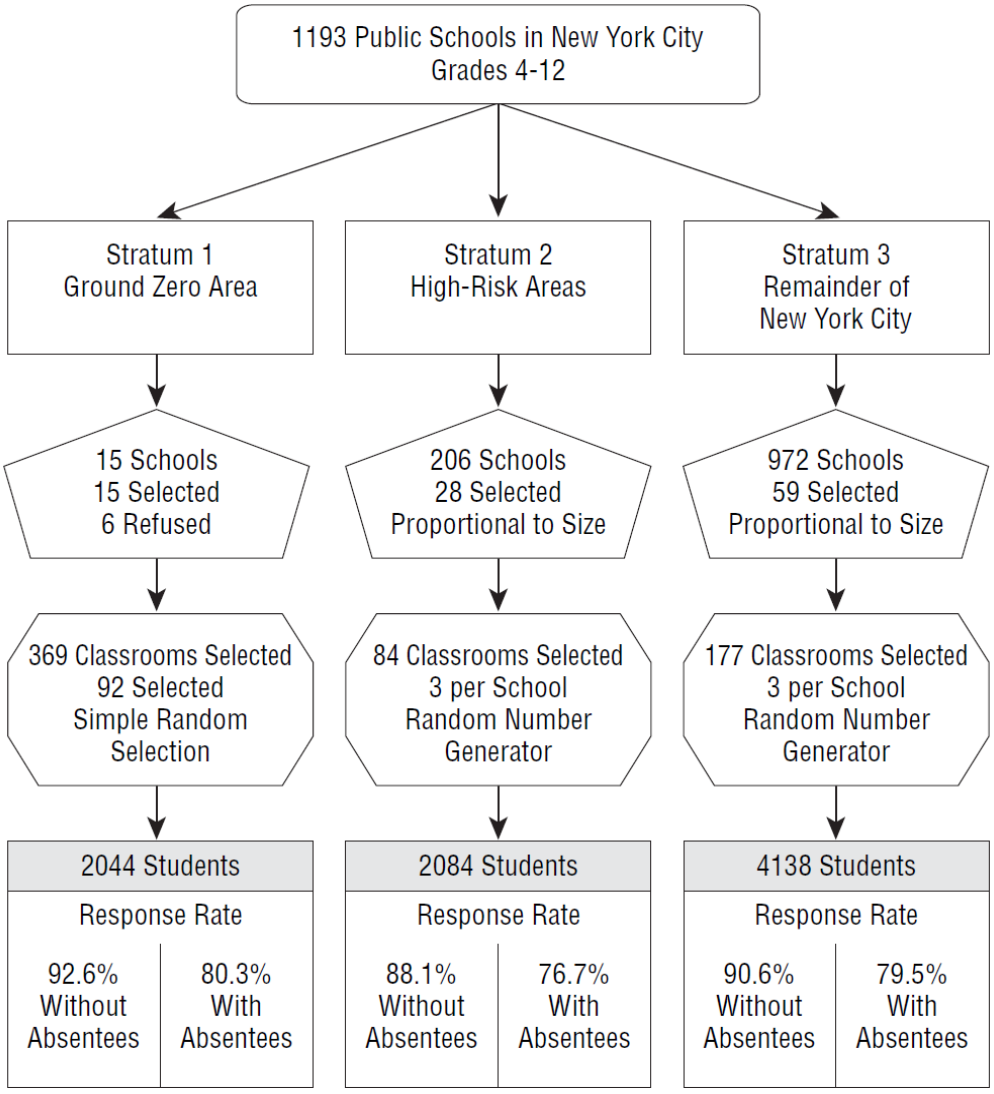

Figure 2. Study sampling methods

Three different versions of the questionnaire were randomly distributed by classroom to 4th-5th graders and to individual students in grades 6-12. The questionnaire was slightly shorter for 4th-5th graders and was read aloud to them by survey personnel as students filled in their responses. The 6th-12th graders read and filled out their own questionnaires.

3.2.1 Demographic variables

Information was obtained about student gender, age, grade, ethnicity, maternal education and family composition.

3.2.2 Probable PTSD

Probable PTSD has been assessed in connection with direct, indirect and/or media exposure to the WTC attack, using two instruments.

DISC. The Diagnostic Interview Schedule for Children (DISC) Predictive Scales (DPS) (Lucas 2001) was used to assess PTSD. The DPS is a self-report youth screening measure derived from the National Institute of Mental Health's Diagnostic Interview Schedule for Children, Version IV (DISC-IV), a structured diagnostic interview for children (Shaffer et al., 2000), and includes those DISC items that are most predictive of *DSM-IV* DISC diagnoses (Lucas et al., 2001). The DPS includes a measure of children's impairment (see below), consistent with DSM-IV criteria in order to better define a probable case. Because the study employed a screening measure, PTSD is here considered as probable, and not definite, disorder. Eight questions were used to evaluate PTSD (Table 2), and they were worded to refer to the WTC attack as the anchoring traumatic event. Questions are dichotomous, requiring yes/no answers. Subjects endorsing 5 or more DPS PTSD symptoms are considered cases (sensitivity, 85%; specificity, 98.4%) (Hoven et al.; Hoven et al., 2005a; Lucas et al., 2001). In addition, another outcome was created that combined the DPS PTSD diagnosis with a positive score on the impairment scale (see below).

PTSD RI. PTSD was assessed also with a nine-item abbreviated version of the University of California at Los Angeles (UCLA) Post-traumatic Stress Disorder Reaction Index (PTSD-RI) for DSM-IV (Pynoos et al., 1998; Steinberg et al., 2004). The PTSD-RI uses a Likert scale to rate the frequency of symptom occurrence over the past month as follows: none=0, little=1, some=2, much=3, and most=4 (score range: 0-36). The abbreviated version of this instrument was appositely developed for conducting efficient needs assessment and screening of students in New York City after September 11, 2001 (Steinberg et al., 2004). The nine-item PTSD-RI has good sensitivity and specificity for detecting cases of PTSD, and good internal consistency (Cronbach's alpha = 0.87); the receiver operator characteristics indicates that the corresponding cutoff to the full scale is 20 (Steinberg et al., 2004). The PTSD-RI was not part of the questionnaire core section; thus, two out of three questionnaires contained the PTSD-RI.

3.2.3 Other psychiatric disorders

The DPS was also used to assess symptoms of other probable psychiatric disorders: major depressive disorder (MDD), conduct disorder (CD), alcohol abuse (ALC), as well as agoraphobia (AGO) and anxiety disorders aside from PTSD: separation anxiety disorder (SAD), generalized anxiety disorder (GAD) and panic disorder (PD).

3.2.4 Exposure to traumatic factors

Specific questions assessed different types of exposure to the WTC attack (Hoven et al., 2002).

Direct exposure. Direct exposure was assessed with the following items: a) personally witnessed the attack (saw the planes crash or the towers collapse in real life), b) physically hurt in the attack, c) in or near the cloud of dust and smoke, and d) evacuated to safety; having experienced two or more of these events is defined as severe direct exposure. An additional item assessed the intensity of worry about the safety of a loved one right after the attack (a little=1, some=2, a lot=3, a whole lot=4).

Indirect exposure. Exposure of family members (mother, father, stepmother, stepfather, foster mother, foster father, sister, brother, grandmother, grandfather, aunt, uncle or other family member) and other people (friend, someone else known by the child) was assessed with 3 questions about a) witnessing the attack but escaping unharmed, b) being injured in the attack, and c) being killed. Six types of indirect exposure were created, based on 2 groups of people (family members; friends/someone else) and 3 events (a, b, and c).

Media exposure. Media exposure was measured asking how much time (none; some; a lot) after the WTC attack the respondent spent learning about the attack from a) TV (and with whom the child watched TV), b) web sites, and c) radio, newspapers or magazines. Items scored as "a lot" were considered positive. For some analyses TV exposure was further divided into I) TV with adults, II) TV without adults.

3.2.5 Impairment

To assess functional impairment we used a global measure of impairment derived for the DPS (Lucas et al.). While global measures do not link impairment to specific disorders, they provide an epidemiological tool in population studies to estimate the proportion of individuals who may be impaired and have a clinically significant condition (Bird et al, 2005). The criteria for impaired functioning (disturbance in social relations, disturbance in occupational or school functioning, and problems in living and taking care of oneself) are similar whether the measure applied is a global impairment measure or a measure linking impairment to a specific diagnosis. According to Bird et al (2005), when an individual is impaired by the symptoms of a specific diagnosis for which he or she meets symptom criteria, he or she should logically also score in the impaired range on a global measure. However, the opposite is not necessarily true; an individual could score in the impaired range on a global measure, even without meeting full criteria for any specific disorder. It is important that these impaired but undiagnosed individuals also be considered in service planning and epidemiology.

The respondents were asked to think about problems they may have been having in the month before the study, at home, at school and/or with other people their age, because of the way they have been feeling or acting. We assessed the frequency (0=not at all, 1=hardly ever, 2=some of the time, 3=a lot of the time) of seven items: a) parents felt worried or concerned, b) parents got annoyed or upset, c) teachers got annoyed or upset, d) the respondent was unable to do things or go to places with the family, e) felt bad or upset, and f) had problems with schoolwork or grades.

The cut-off score was set low, as recommended for screening purposes to maximize case detection (increased sensitivity); this strategy captures most of those truly impaired (true positives) at the expense of screening in a significant number of false positives (Bird et al, 2005). Items scored as 0 (not at all) and 1 (hardly ever) were recoded as 0, items scored as 2 (some of the time) were recoded as 3, and items scored as 3 (a lot of the time) were recoded as 6; respondents were considered impaired with scores (after recoding) ≥ 9.

3.2.6 Grief

Respondents who lost someone as a consequence of the WTC attack were asked about the intensity of grief symptoms in the past month (0=not at all, 1=somewhat, 2=a lot). Grief was assessed with the following items: a) "I miss the person who died", b) "I don't do things because they remind me of the person who died", c) "I can't stop thinking about the person who died", d) "She/he still is an important part of my life", and e) "I try not to talk about the person who died because it is too painful". Problematic grief was defined as having at least two items coded as 2 (a lot).

3.2.7 Other variables

Exposure to traumatic events before and after 9/11. The assessment of exposure to traumatic events not related to the WTC attack was assessed with the following items: a) badly hurt in a violent or accidental situation, b) seen anyone killed or seriously injured, c) a close friend has been badly hurt or killed in an accident or violent situation, d) a family member has been killed in an accident or violent situation, e) lived in another country while there was a war going on there, and f) been in a big disaster that badly damaged the building the child was in or killed people she/he knew.

Behavior of friends. Respondents were asked with what frequency (0=not at all, 1=somewhat, 2=a lot) since the WTC attack their friends: a) drink more alcohol, b) smoke more cigarettes, c) talk more about suicide, d) use more violence against others, and e) show more prejudice towards people because of their race, look, religion or nationality. Items scored as "a lot" are considered positive.

WTC attack-related life disruption. Respondents were asked whether they experienced any of the following: a) family relocation ("After the attack did you have to move out of your home?"), b) family job loss ("Because of the attack on the WTC, has anyone in your family lost her/his job?"), c) restricted travel ("Since September 11th, have your parents cut down on your freedom to travel around the city?"), d) school closure ("Did you have to attend another school because your school was closed due to the WTC attack?"), and e) school relocation ("Have your parents moved you to a different school because of the WTC attacks?").

Support. To have an index of support for issues related to the WTC attack the respondents were asked if they have someone they can talk to about the WTC attack (yes/no answer).

Job of family members. Three items asked if anyone in the family a) work as a police officer, fire fighter, emergency medical technician, in the military, or as a postal worker, b) has been working in rescue or relief services at the WTC or c) now work in a building near the WTC. For the first item, a variable was created to capture subjects with at least 1 family member working as a police officer, fire fighter, emergency medical technician or in the military.

Racism. The experience of racism was assessed asking the respondents how often (0=not at all, 1=somewhat, 2=a lot) they have been treated badly since 9/11 because of race or religious beliefs. If the respondent answered "a lot", the item was considered positive.

Negative monitoring and attachment. It was assessed how often (1=never/almost never, 2=once in a while, 3=fairly often, 4=very often) a) the parents know where the respondent is when she/he is away from home, b) ask about something bothering the respondent if they know about it, and c) how often the respondent tell her/his parents about problems and troubles. Items scored as 1 or 2 were considered positive (i.e., negative monitoring and attachment).

3.3 Statistical Analysis

3.3.1 Multiple Correspondence Analysis (MCA)

Multiple Correspondence Analysis (MCA) is a generalization of simple correspondence analysis and is specifically designed for handling larger, more complex datasets, including the high-dimensional data often encountered in questionnaires of large epidemiological studies to investigate individual psychological conditions. In particular, MCA is a useful technique for the structural analysis of multivariate categorical data (Greenacre and Blasius, 2006). MCA, is mostly a descriptive rather than inferential statistical approach essentially designed to facilitate our intuitive understanding of the relationships among the categories of the variables.

The overall aim is to identify the principal dimensions or axes of the space that capture as much as possible of the inertia, which may be interpreted as the explained variance. The mathematics involved in creating dimensions is complex. In summary, MCA is performed by applying the Correspondence Analysis algorithm to a matrix of indicators (i.e. individuals responses to categorical symptoms variables), in which rows represents individuals and columns the categorical variables. Associations between variables are uncovered by calculating the chi-square distance between different categories of the variables and between the individuals. The oppositions between rows and columns are then maximized in order to uncover the underlying dimensions best able to describe the central oppositions in the data. The result of the matrix analysis is the identification of axes of variation that reduce the data to a small number of dimensions, describing as much variability as possible; they are defined as the top eigenvectors of the indicators matrix between samples. Accordingly, individuals will be easily represented as points in

a geometric space, i.e. the Euclidean space, where the coordinates will be determined by the individual scores on each axes. As in factor analysis and principal component analysis, the number of dimensions to be retained for analysis is determined by several rules of thumb: 1) Inertia (total variation in the dataset); the number of dimensions retained should represent ~ 70% of the inertia; 2) eigenvalues; dimensions with eigenvalues larger than 1 should be retained; 3) screeplot: dimensions with eigenvalues right before the ‘‘elbow’’ in a screeplot (i.e. plot of the eigenvalues) should be retained. The ‘‘elbow’’ corresponds to the dimension where the curve begins to level off. The dimensions can be interpreted based on how the variables’ response categories separate on either side of the dimensions.

Initially, MCA was performed to infer continuous axes of symptomatology variation on the whole set of the DPS symptoms, which cover the screening of eight different probable diagnosis. Intuitively, axes that represent the variation of symptoms differences between samples may have a diagnostic interpretation. For example, an axis describing internalizing disorders symptoms would have values that gradually range from positive for samples that have a probable diagnosis of any internalizing disorder, to near zero for healthy control samples. The analyses were perfomed using the R package FactoMineR (Husson et al., 2008).

3.3.2 Multivariate logistic regression

Individual respondent weights were used, reflecting the sampling design for grade level and stratum. Individually omitted items (unplanned missings) were imputed from other data (items on scales, write-ins, demographics, or school variables) or by using multiple imputation in the case of sex, maternal education, family composition, and probable psychiatric disorders (SAS MI procedure). Multiple imputation was also used for variables that were not part of the core section of the questionnaire (planned missings). Approximately 12 variables, conceptually and empirically correlated with each variable with missing information, were used for imputation (planned and unplanned missings). For probable disorders, where needed, each symptom was individually imputed, and recommended symptom-count cutoffs were applied to determine probable disorder. Unplanned missing values ranged from 1% to 5.3%, and planned missing values ranged from 5.4% (for major depressive disorder and generalized anxiety disorder, which were non-core only for 4th-5th graders) to 34.3%, including the remaining 4 disorders, which were non-core for the entire sample. To verify the impact of imputation on the results, parameter estimates and standard errors were calculated for the original (unimputed) and fully imputed data (unplanned and planned missing values imputed) and compared; considering the individual disorders that were part of the main outcome variable (any anxious/depressive disorder), after full imputation, parameter estimates never varied more than 0.6% compared with the original, unimputed values. Variations in the estimated odds ratio and adjusted odds ratio (AOR), measuring the association between demographics and exposure with “any anxious/depressive disorder”, were never more than 0.22.

In first set of multivariate logistic regressions (Step 1), items belonging to the same group (e.g., demographics, direct exposure, indirect exposure, etc.) were used as predictors of DPS PTSD (without and with impairment): a) 5 demographics, b) 4 direct exposure items, c) 6 indirect exposure items, d) 3 media exposure items (TV exposure has two levels, defined by the presence vs absence of adults while watching TV), f) grief, g) 6 items measuring exposure before and after 9/11 (each variable had 3 levels defined by exposure before 9/11, after 9/11, and before and after 9/11), h) difficulty getting home on 9/11, i) smelling the smoke coming from the WTC in the 2 days following 9/11, j) 5 variables of life disruption, k) racism, l) 5 variables assessing friends' behaviors, m) 3 variables assessing monitorin/attachment, n) support, and 0) 3 variables related to the job of family members. All regressions were adjusted for the 5 demographic variables. From this first set of analyses, significant ($p<0.05$) and marginally significant ($p<0.1$) risk factors for DPS PTSD, without or with impairment, were included in the second set of analyses. In this second set of analyses (Step 2), significant and marginally significant variables from Step 1 were analyzed together in two sets of multivariate logistic regressions: variables assessing direct, indirect, and media exposure (Step 2a), and all other variables (Step 2b). To test the role of grief as a mediator of the relationship between the two variables measuring death of a loved one (death of a family member; death of a friend), a multivariate logistic regression (Step 3) was run using grief as the outcome and the same variables included in Step 2a as predictors (the association between grief and PTSD was already part of Step 1); a multivariate logistic regression with DPS PTSD (without and with impairment) as the outcome and the same variables included in Step 2b plus grief was then run (Step 4). Significant and marginally significant variables from Step 2b and from Step 4 were analyzed together in a next set of multivariate logistic regressions (Step 5). Finally, significant and marginally significant variables from Step 5 were analyzed together to obtain a final model (Step 6); the final model was for DPS PTSD was analyzed adjusted and unadjusted for MDD. The same procedure was used with PTSD-RI PTSD (Cut off =20) and with DPS MDD as outcomes. The final model was for MDD was analyzed adjusted and unadjusted for DPS PTSD. These analyses were conducted using the statistical software SUDAAN Version 8.0 (ResearchTriangleInstitute) to account for clustering of the data due to sampling design.

3.3.3 Latent Class Analysis

3.3.3.1 PTSD symptoms

LCA probabilistically groups each observation into a "latent class," without any a priori assumption about the nature of the latent categorization, identifying and characterizing clusters of cases with similar symptom profiles. LCA was performed using the poLCA function implemented in the R package poLCA - An R Package for Polytomous Variable Latent Class Analysis (Linzer and Lewis, 2011a; Linzer and Lewis, 2011b; Team, 2010). The graphs were realized using the R package ggplot2 (Wickham, 2009)

The LCA models were fit starting with a two-class model, increasing the number of classes up to six. The log-likelihood ratio statistic (G^2) with number of parameters (k) and the Bayesian Information Criterion (BIC) were compared across models. To select the most parsimonious and best fitting model, the model that minimizes values of the G^2 and BIC was identified without estimating excessive number of parameters. BIC screeplot was used to improve the selection of the model solution with the most appropriate number of latent classes.

The differences of We evaluated quantitative differences among classes (ie, differences in the level of severity of symptom profiles) by calculating the sum of the conditional probability of each symptom within a class. To investigate qualitative differences among classes (ie, configurational differences in the relative prevalence of symptoms), we calculated the odds ratios (ORs) of reporting a symptom in different classes, along with a 1-sided Fisher's exact test (significance level was set at $p < .001$ after Bonferroni correction). Comparing two classes, the ORs of the probability of symptom endorsement indicate which symptoms better distinguish one class compared to the other.

was applied to the 8 DPS PTSD items in the whole sample of trauma-exposed individuals (N = 6,733; Table 1). LCA models were evaluated also across gender and age group by gender (ie, male vs. females in 4th-8th grades, and male vs. females in 9th-12th grades).

Second, LCA was applied to 13 exposure variables to identify profiles of trauma-exposure. LCA models were fitted using the 8 DPS PTSD items within each trauma-exposure class to examine differences in symptom profiles across trauma-exposure subgroups. Within each trauma-exposure subgroup, Latent class logistic regression (LCLR) was applied to the 8 DPS PTSD items, with gender and age as covariates, to identify potential class membership differences associated with these two demographic variables. LCLR allows including the effects of the covariates on the prior probabilities of latent class membership. As a result, the individuals' latent class membership, normally assumed to be the same for every subject, depended on the values of the covariates.

, to investigate the relationship between PTSD symptoms' profiles and functional impairment, LCA was simultaneously applied to the 8 DPS PTSD items and the 7 DPS impairment indicators.

Finally, a logistic regression was performed to study the association between latent classes defined by PTSD symptoms and impairment indicators PTSD, and additional probable disorders (MDD, SAD, and CD).

3.3.3.2 PTSD symptoms and symptoms of other disorders

LCA was used to characterize the underlying structure of PTSD symptoms and symptoms from the other disorders assessed in the survey. Examination of disorder co-occurrence in this manner removes distinctions placed by current diagnostic criteria and allows for the grouping of symptoms and disorders to be seen as they naturally occur (Volk 2005). LCA was simultaneously applied to 8 PTDS symptoms, 7

SAD symptoms, 6 Agoraphobia symptoms, 4 GAD symptoms, 2 PD symptoms, 9 MDD symptoms, and 13 CD symptoms. In some analyses 4 symptoms related to problem drinking were also included. Latent class models were fitted to the data, consisting of 1-15 class solutions, using the poLCA function implemented in the R package poLCA - An R Package for Polytomous Variable Latent Class Analysis (Linzer and Lewis, 2011a; Linzer and Lewis, 2011b; Team, 2010). The graphs were realized using the R package ggplot2 (Wickham, 2009). The best-fitting class solution was chosen based criteria previously described. Using LCA in this manner will allow our study to systematically examine the underlying structure of PTSD and comorbid psychopathology.

3.3.4 Item Response Theory (IRT)

An exploratory factor analysis was used to test the IRT assumption of unidimensionality for a two-parameter logistic model; these analyses were performed using R (Team, 2010). The *a* and *b* parameters of the IRT model are most interpretable when the criteria reflect a single unitary dimension. In factor analysis, unidimensionality is established by demonstrating that a one-factor model provides the most parsimonious fit to the data.

For IRT analyses, a two-parameter logistic (2PL) model was chosen for this study, as opposed to a three-parameter model, because the former allows both the *a* and *b* parameters to vary in order to describe the item. The latter includes a third parameter, the *c* parameter, also known as the guessing parameter. While three-parameter models are useful in the cognitive and educational testing literature where some amount of guessing may be present, it is assumed that there is no amount of "guessing" with the PTSD criteria. In other words, the individual either possesses the criterion or does not.

The IRT analyses in the whole sample were performed using *MULTILOG 7.03* (Thissen, 2003). IRT analyses were obtained by first generating the item characteristic curve (ICC) for each criterion and the test characteristic curves (TIC) for the DPS and PTSD-RI. The PTSD criteria sets of the PTSD-RI were evaluated in a step-wise fashion. Variables for the PTSD-RI were first dichotomized so that a score of 1, 2, 3, or 4 for a criterion indicated that the criterion was present, while a score of 0 indicated that the criterion was not present. Variables for the PTSD-RI were then dichotomized so that a score of 2, 3, or 4 for a criterion indicated that the criterion was present, while a score of 0 or 1 indicated that the criterion was not present. Finally, variables for the PTSD-RI were dichotomized so that a score of 3 or 4 for a criterion indicated that the criterion was present, while a score of 0, 1, or 2 indicated that the criterion was not present. The IRT analyses in the 4 subsamples defined by gender and age ($\leq$13; $\geq$14) were performed using *MPLUS 3.12* (Muthén & Muthén, 2005).

The IRT model yields marginal maximum likelihood estimates of two parameters: the *a* (discrimination) parameter, and the *b* (threshold or severity) parameter. The *a* parameter measures the ability of a criterion to discriminate people who are higher on the continuum and those who are lower on the continuum. This

parameter describes how strongly the criterion is related to the underlying trait or construct. The *a* parameter is analogous to a factor loading in traditional factor analysis. The larger the *a* parameter (i.e. the slope at its steepest point), the greater the discrimination of a criterion. The *b* parameter measures the severity of a criterion. The *b* value indicates the level of severity at which, for a particular item, an individual would have a 50% chance of endorsing the item; criteria with high thresholds are endorsed less frequently and are more severe.

The *a* and *b* parameters are plotted graphically as item characteristic curves (ICCs). In these plots the *b* parameter represents the criterion's location along the latent continuum (located on the horizontal axis). The *b* parameter shifts the ICC from left to right as the criterion becomes more severe. The *a* or discrimination parameter indicates how steep the slope of the ICC is at its steepest point. In addition to constructing ICCs for each criterion, a test information curve (TIC) was also constructed. The TIC graphically depicts the information value of the criteria as a collective or in the aggregate.

3.3.4.1 Differential item functioning (DIF)

To determine whether any of the PTSD criteria displayed DIF, the *a* and *b* parameters were statistically compared for each criterion across four subsamples defined by sex and age (8-13; 14-21). The presence of DIF suggests an item-by-group interaction. The IRT log-likelihood ratio test for differential item functioning program (IRTLRDIF, version 2.0; (Thissen, 2001)) was utilized to assess whether the PTSD criteria function differently in the fours subsamples defined by gender and age. Within this framework, DIF is said to occur when the *a* or *b* parameter associated with a given criterion differs significantly across groups, after controlling for the underlying trait under investigation (Thissen, 2001). All eight DPS PTSD criteria and all nine PTSD-RI criteria were submitted for analysis and each criterion was tested for the presence of DIF using the remaining criteria as the temporary anchor set. For each criterion, the likelihood-ratio test statistic (G^2) was generated; G^2 evaluates the difference in fit between a model where the *a* and *b* parameters are constrained to equality between the two groups, with a model where the parameters for the studied item are freed and estimated separately between the two groups. If the G^2 statistic exceeded 3.84 (i.e., the critical value associated with $\alpha = 0.05$ in a χ^2 distribution with 1 degree of freedom), the criterion was considered to potentially exhibit DIF in one or both parameters.

decoding ring follows:

For items for which the G^2 test of the hypothesis that all parameters (2, for the 2PL model) are equal for the groups being compared does not exceed 3.84, only one line is in the output file. Among other values (not reported in the results), this line contains the item number, the hypothesis being tested ("All equal"), the value of the G^2 statistic. For items for which the G^2 test of the hypothesis that all parameters are equal for the groups being compared exceeds 3.84, there are additional lines in the output file. Among other values (not reported in the results), the additional lines contain labels for the two single degree of freedom

hypothesis tests, and their G^2 statistics. In addition, those lines contain the item parameter estimates from which the single degree of freedom tests are derived: the first of these additional lines shows the item parameters for the two groups being compared with the discrimination (*a*) parameter constrained equal, the second shows the item parameter estimates with both the *a* parameter and the severity (*b*) parameter constrained equal.

Differences in a criterion's discrimination parameter *a* between groups indicate the degree to which a criterion is related to the underlying trait differences between groups, or alternatively that reliability of the criterion varies by group. DIFs related to difference in a criterion's severity parameter *b* between groups suggests that unequal levels of the trait are necessary to endorse the criterion; in other words, DIF in the item severity parameter suggests that symptoms are of unequal severity across groups (Gelhorn et al., 2009).

4 RESULTS

4.1 Demographics

Demographic variables and other variables included in the analyses are reported in Table 1 and Table 2, respectively. In the total sample, 52.4% of respondents were female; 50.62% of the students were in grades 4-8. Hispanic ethnicity was the most frequent (35.65%), followed by African American (22.52%), Asian (18.84 %), White (18.08%, and Mixed/Other ethnicity (4.91%). These weighted percentages are similar to those reported by the NYC Department of Education for grades 4-12 during the 2001-2002 school year (Hoven et al., 2005). Maternal education was low for 17.28% of the respondent, and 36.23% didn't live with both parents.

Table 1. Demographic variables

Variables	N	%
Gender		
Female	4374	53.11
Male*	3862	46.89
Age		
Grade=4-8	4859	59.00
Grade=9-12*	3377	41.00
Race		
Black	2302	27.95
Hispanic	3302	40.09
Asian	1058	12.85
Mixed/Other	472	5.73
White*	1102	13.38
Maternal education		
<High School	1404	17.05
>=High School*	6831	82.94
Family composition		
Not live with both parents	3196	38.81
Live with both parents *	5040	61.19

*Reference group

4.2 Frequency of disorders/comorbidity

The epidemiology of PTSD and other disorders assessed in the survey is reported in Table 3. PTSD measured with was positive for 1,261 subjects (14.76%); of those, 870 (71.56%) were also positive for impairment. Table 3 shows also comorbidity frequencies (and bivariate associations) for the 8 disorders assessed with the DPS (PTSD, SAD, GAD, AG, PD, MDD, CD, ALC), and for PTSD assessed with the PTSD-RI. DPS PTSD DPS is highly comorbid with all internalizing disorders; rates of comorbidity between PTSD and SAD, and between PTSD and AG are particularly high (50.86% and 60.13% of PTSD cases, respectively). On the contrary, the co-occurrence of PTSD and CD, and PTSD and ALC (two externalizing disorders) is less frequent (15.73% and 5.59%, respectively) and not significant.

Table 2. Other variables

	Respondents		Missing	
Variables	**N**	**%**	**N**	**%**
Grief	486	5.90		
Exposure to other potentially traumatic event before, after or before and after 9/11				
Badly hurt in a violent or accidental situation; before	1154	14.01		
Badly hurt in a violent or accidental situation; after	149	1.81	154	1.87
Badly hurt in a violent or accidental situation; before & after	29	0.35		
Saw anyone killed or seriously injured; before	2844	34.53		
Saw anyone killed or seriously injured; after	661	8.03	189	2.29
Saw anyone killed or seriously injured; before & after	408	4.95		
A close friend was badly hurt or killed in an accident or violent situation; before	2066	25.08		
A close friend was badly hurt or killed in an accident or violent situation; after	403	4.89	209	2.54
A close friend was badly hurt or killed in an accident or violent situation; before & after	163	1.98		
A family member was killed in an accident or violent situation; before	1996	24.24		
A family member was killed in an accident or violent situation; after	254	3.08	248	3.01
A family member was killed in an accident or violent situation; before & after	62	0.75		
Lived in another country while there was a war going on there; before	393	4.77		
Lived in another country while there was a war going on there; after	79	0.96	195	2.37
Lived in another country while there was a war going on there; before&after	7	0.08		
In a big disaster that badly damaged the building or killed known people; before	341	4.14		
In a big disaster that badly damaged the building or killed known people; after	72	0.87	192	2.33
In a big disaster that badly damaged the building or killed known people; before & after	9	0.11		
Difficulty getting home	2639	32.04	70	0.85
Smelled the smoke from WTC	3249	39.45	91	1.10
Life disruption				
Moved out of home	58	0.70	67	0.81
School closure	135	1.64	46	0.56
School relocation	79	0.96	645	7.83
Restricted travel	2291	27.82	296	3.59
Family job loss	1391	16.89	200	2.43
Racism	350	4.25	3189	38.72
Friends' behaviors				
Drink more alcohol	96	1.17	2085	25.32
Smoke more cigarettes	146	1.77	2085	25.32
Talk more about suicide	79	0.96	4285	52.03
Use more physical violence	167	2.03	4283	52.00
Show more prejudice	549	6.67	4273	51.88
Monitoring/attachment				
Parents rarely/never know where the subject is when he/she is away from home	375	4.55	3091	37.53
The subject rarely/never tell his/her parents about problems and troubles	1426	17.31	3082	37.42
Even if parents know something is bothering the subject, they rarely/never ask about it	608	7.38	3097	37.60
Lack of support	6109	74.17		
Relatives' job				
≥1 FR in the family	1791	21.75		
Rescue/relief at the WTC	1118	13.57	251	3.05
Works near WTC	2075	25.19	252	3.06

Table 3. Comorbidity among disorders.

A. The values indicate frequency and percentage (in parenthesis) of comorbidity of each outcome (columns) in each outcome (rows). Highlighted in grey are the frequencies and percentage of the total sample of each disorder. Thus, for example, of the 1067 subjects with GAD (12.96% of the total sample), 477 (44.72% of subjects with GAD) have comorbid SAD.

	Freq. (%)	Freq. (%)	Freq. (%)	Freq. (%)	Freq. (%)	Freq. (%)	Freq. (%)	Freq. (%)	Freq. (%)	Freq. (%)
	PTSD-RI	**PTSD DPS**	**SAD**	**GAD**	**AGO**	**PD**	**MDD**	**CD**	**ALC**	**Impair.**
PTSD-RI	625 (7.59)	506 (80.86)	367 (58.67)	245 (39.22)	420 (67.17)	237 (37.83)	187 (29.88)	109 (17.40)	23 (8.52)	
PTSD DPS	506 (41.59)	1216 (14.76)	618 (50.86)	356 (29.32)	731 (60.13)	363 (29.88)	267 (22.00)	191 (15.73)	33 (5.59)	870 (71.56)
SAD	367 (26.12)	618 (44.02)	1404 (17.05)	477 (33.98)	768 (54.67)	455 (32.42)	328 (23.32)	259 (18.46)	55 (6.89)	1016 (72.35)
GAD	245 (22.98)	356 (33.40)	477 (44.72)	1067 (12.96)	481 (45.06)	355 (33.27)	328 (30.72)	274 (25.71)	58 (7.41)	849 (79.60)
AGO	420 (24.22)	731 (42.16)	768 (44.28)	481 (27.73)	1734 (21.05)	441 (25.41)	378 (21.81)	288 (16.62)	61 (6.22)	1223 (70.52)
PD	237 (24.87)	363 (38.19)	455 (47.88)	355 (37.32)	441 (46.32)	951 (11.55)	260 (27.30)	224 (23.52)	35 (5.63)	719 (75.59)
MDD	187 (25.42)	267 (36.38)	328 (44.56)	328 (44.59)	378 (51.45)	260 (35.33)	735 (8.92)	212 (28.89)	51 (9.05)	666 (90.65)
CD	109 (10.34)	191 (18.16)	259 (24.63)	274 (26.07)	288 (27.37)	224 (21.26)	212 (20.18)	1052 (12.78)	108 (12.65)	
ALC	23 (8.11)	33 (11.97)	55 (19.93)	58 (20.80)	61 (22.09)	35 (12.80)	51 (18.48)	108 (38.92)	277 (4.51)	

B. Bivariate association between disorders; chi-squares and P-values (in parenthesis) are reported.

PTSD-RI	**24.25 (0.0000)**	**16.42 (0.0001)**	**11.33 (0.0009)**	**18.63 (0.0000)**	**18.11 (0.0000)**	**17.98 (0.0000)**	1.58 (0.2112)	1.42 (0.2355)
PTSD DPS		**24.04 (0.0000)**	**14.19 (0.0002)**	**28.36 (0.0000)**	**22.32 (0.0000)**	**21.13 (0.0000)**	1.56 (0.2127)	0.38 (0.5399)
SAD			**27.31 (0.0000)**	**30.70 (0.0000)**	**34.28 (0.0000)**	**24.73 (0.0000)**	3.81 (0.0526)	1.59 (0.2091)
GAD				**20.95 (0.0000)**	**33.04 (0.0000)**	**42.41 (0.0000)**	**23.66 (0.0000)**	**3.92 (0.0493)**
AGO					**31.29 (0.0000)**	**29.96 (0.0000)**	3.42 (0.0662)	1.15 (0.2857)
PD						**25.54 (0.0000)**	**11.95 (0.0007)**	0.38 (0.5392)
MDD							**14.33 (0.0002)**	2.78 (0.0973)
CD								**9.95 (0.0019)**

*The DPS does not consider a diagnosis of CD with impairment and ALC with impairment; the PTSD-RI scale does not have a measure of impairment

4.3 Multiple Correspondence Analyses identifies axes of variation in psychopathology

As mentioned earlier, these data consist of 8,236 subjects responding to 52 items, grouped in 8 probable disorders, seven of which were assessed with the DPS and one with PTSD-RI. Each item has two response categories, with the only exception of PTSD-RI items that are structured in a Likert scale that ranges from "little" to "most". For the purpose of this analysis, the items of alcohol abuse were discarded as the relative questions of the questionnaire were administered only to a subgroup of the sample, i.e. subjects in grade 6th or above. The screeplot method was applied to estimate the number of dimensions to retain (Figure 3).

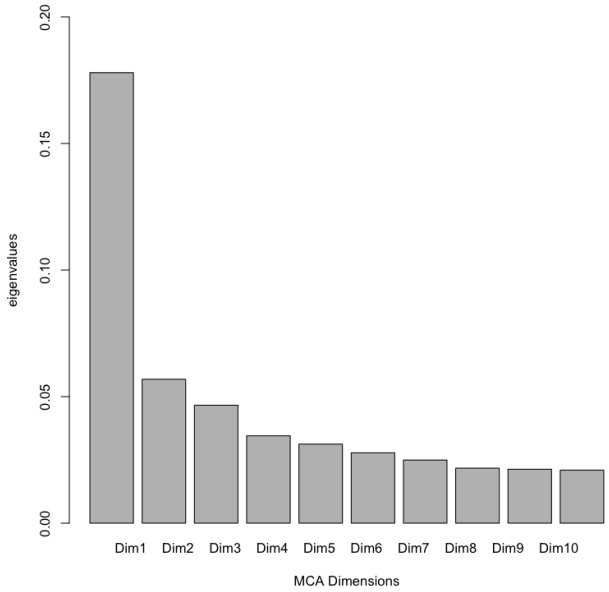

Figure 3. Screeplot of MCA eigenvalues.

The top four dimensions describe the salient relationships, with a cumulative variance explained of 19.45. The top two dimensions are shown in Figure 4. Several categorical supplementary variables, i.e. the DPS probable diagnoses, age and gender, were add to the MCA. Supplementary variables are projected onto the dimensions after the original analysis on the variables of interest is carried out. In this way, the additional variables do not contribute to the inertia, nor do they affect the original results. However, their position on the plot allow to seeing how the primary variables of interest relate to the supplementary variables.

The first dimension represents the largest amount of explained inertia (10.83) or largest deviation from independence. Inertia is a measure of the variance of the individual profiles around the average profile and represent a measure of deviation form independence. Dimensions are formed by identifying those axes of for which the distance between the profiles and the axes is minimized while simultaneously maximizing the amount of explained inertia.

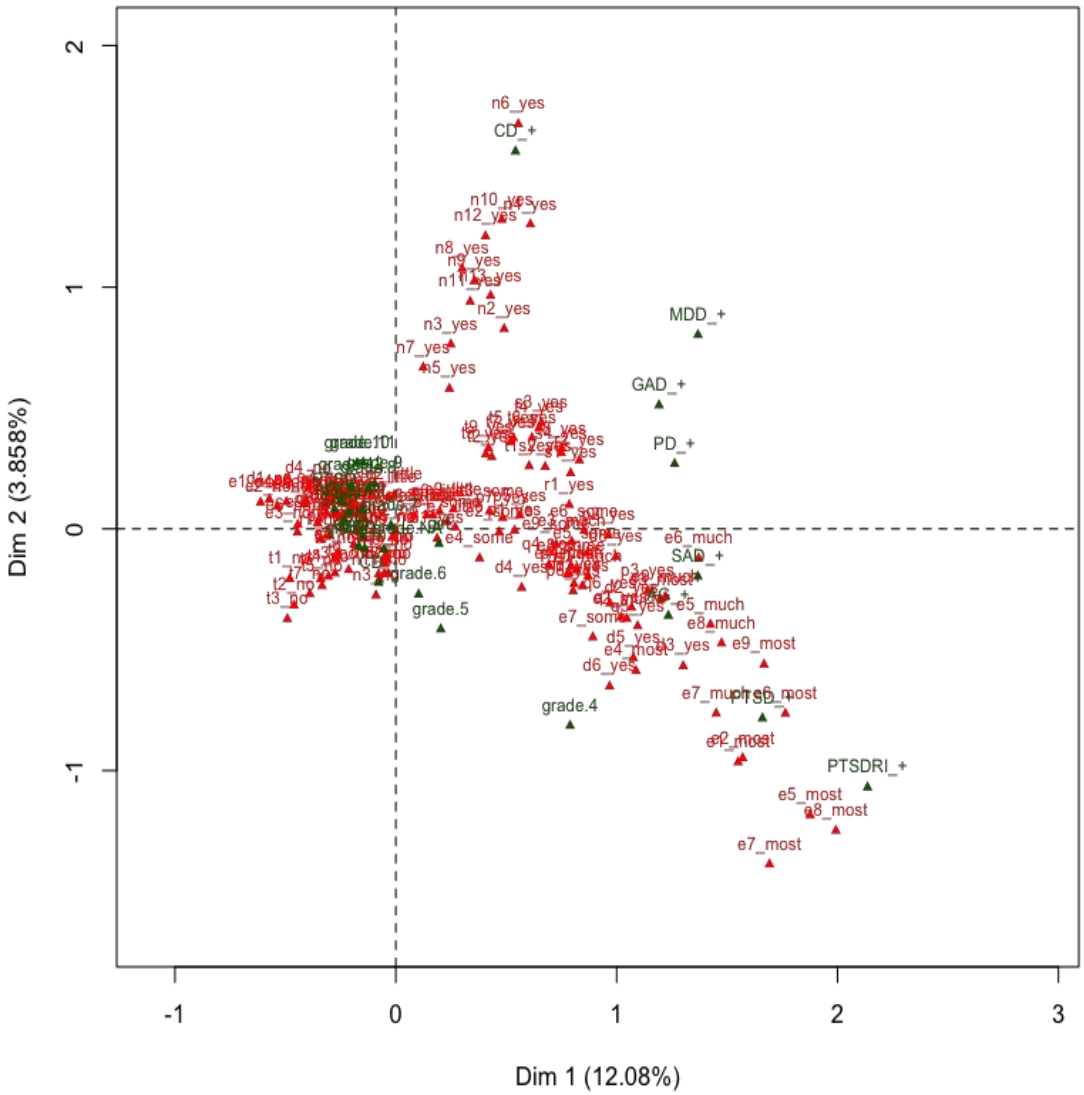

Figure 4. MCA factor map of dimension 1 and 2.

It was hypothesized that the first axis reflects the variation of psychopathology between a condition of no distress and the manifestation of externalizing and internalizing symptoms, which is also supported by its positive correlation with DPS probable diagnoses, i.e the supplementary variables. Individuals without any probable diagnosis amongst the 8 DPS disorders cluster around the origin of the axes (0,0) of the Euclidean geometric space represented by the plot in Figure 4. This implies that these subjects likely answered in the same way across the different psychological batteries and that the answer did not positively correlate with either dimensions computed by the MCA. This result indicates that the most important difference or largest deviation from independence in the sample is between subjects that report the endorsement of psychopathology symptoms and those who do not report any. The first axis orders the categories of symptomatology from the least to the most represented group of symptoms. The positive

correlation values of each categorical probable diagnosis with the first axis identify the fraction of the samples that provide the bulk of psychopathological symptoms.

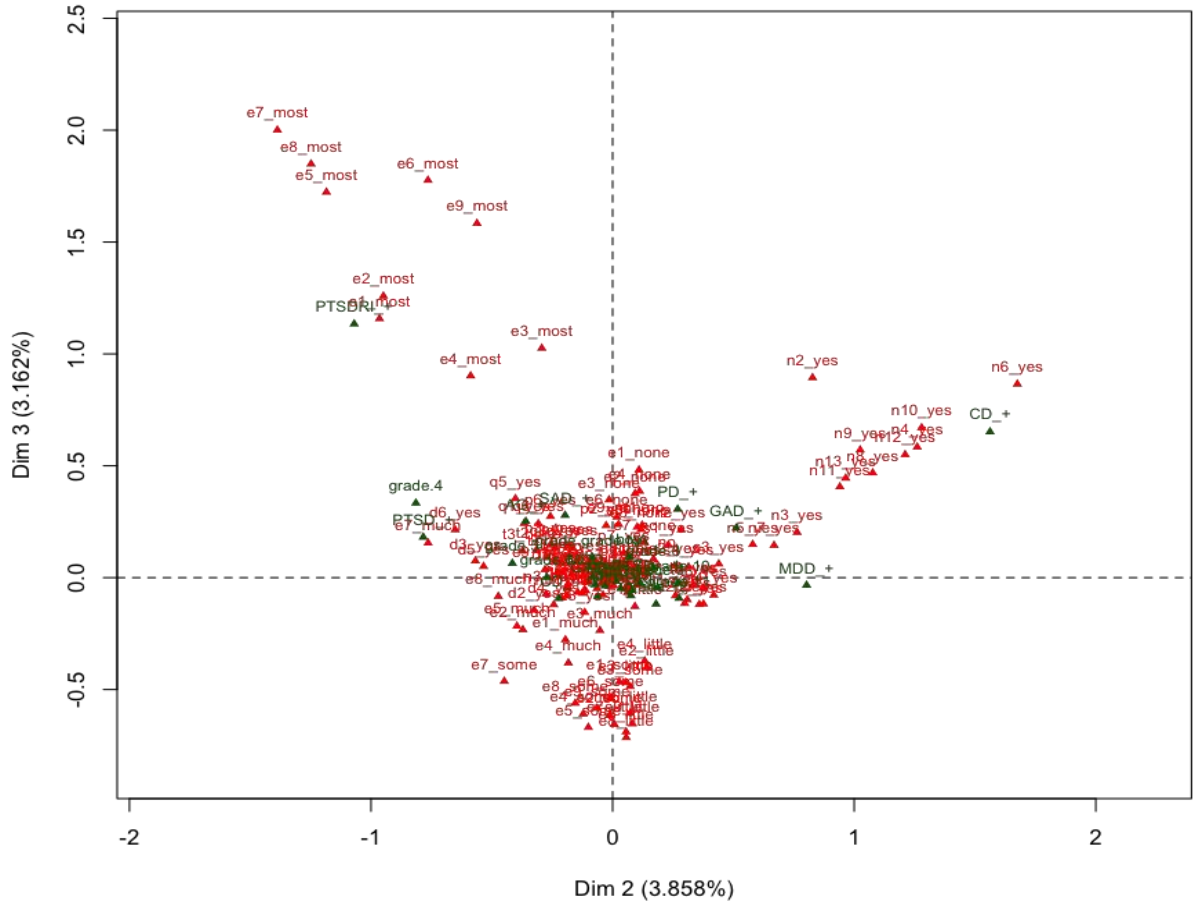

Figure 5. MCA factor map of dimension 2 and 3.

The second most important difference in the sample is represented by the second axis that separates internalizing from externalizing disorders. In particular, probable diagnosis of Conduct Disorder shows positive correlation with the second axis, as opposed to negative correlation for PTSD-RI, DPS PTSD, SAD, agoraphobia. The remaining internalizing disorders, i.e. GAD, panic disorder and MDD, show moderately positive values of correlation, but still a tendency to cluster together with the negatively correlated internalizing disorders. This additional separation within the internalizing disorders cluster might be explained by the age of the subjects that qualify for the DPS probable diagnoses. The first cluster of PTSD-RI, DPS PTSD, SAD, agoraphobia correlates with younger age, i.e. children in 4th and 5th grade, while the second internalizing cluster correlates with older age. i.e. from 6th to 12th grade. At the extreme opposite of children that qualify for PTSD-RI disorder, we found young adolescents that qualify for conduct disorder probable diagnosis. This evidence seems to suggest that the second axis of

variation might be informative for what concerns the differential manifestation of psychopathology symptoms according to various developmental stages.

The third dimension focuses on PTSD symptoms, either assessed with DPS and PTSD-RI (Figure 5). In particular it provides a gradient of severity of the psychological reaction to the traumatic event. The most extreme answers in the Likert scale of the PTSD-RI items, i.e. the "most" answers, positively correlate with the third axis of variation as opposite to the answers "little".

The fourth axis accounts for a very small percentage of the variance explained, but it is very interesting as it provides a first indication of potential comorbidity patterns in the sample (Figure 6). The positive correlation values for conduct disorder symptoms and specific PTSD symptoms related to the hyperarousal category seems to specifically define an externalizing behavior dimension that overcomes the diagnostic category. MCA plots of the four top dimensions with supplementary variables only (diagnosis, age and gender) are shown in Figure 7 and Figure 8.

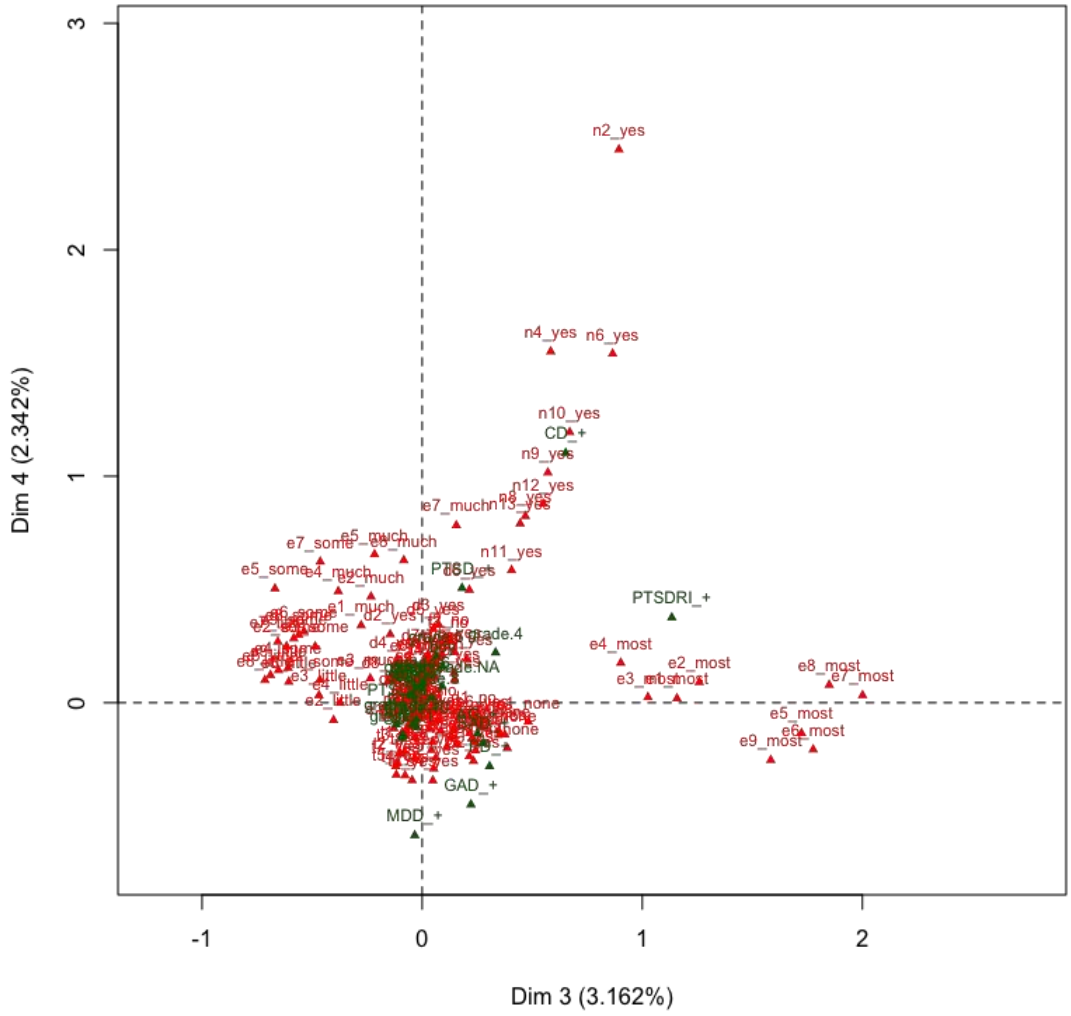

Figure 6. MCA factor map of dimension 3 and 4.

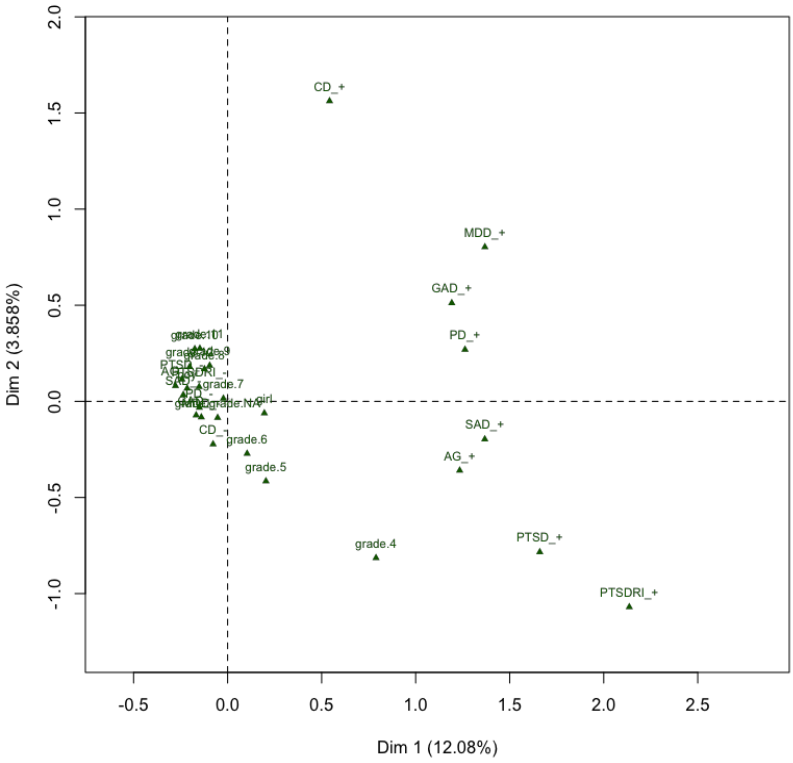

Figure 7. MCA factor map of dimension 1 and 2 with supplementary variables only.

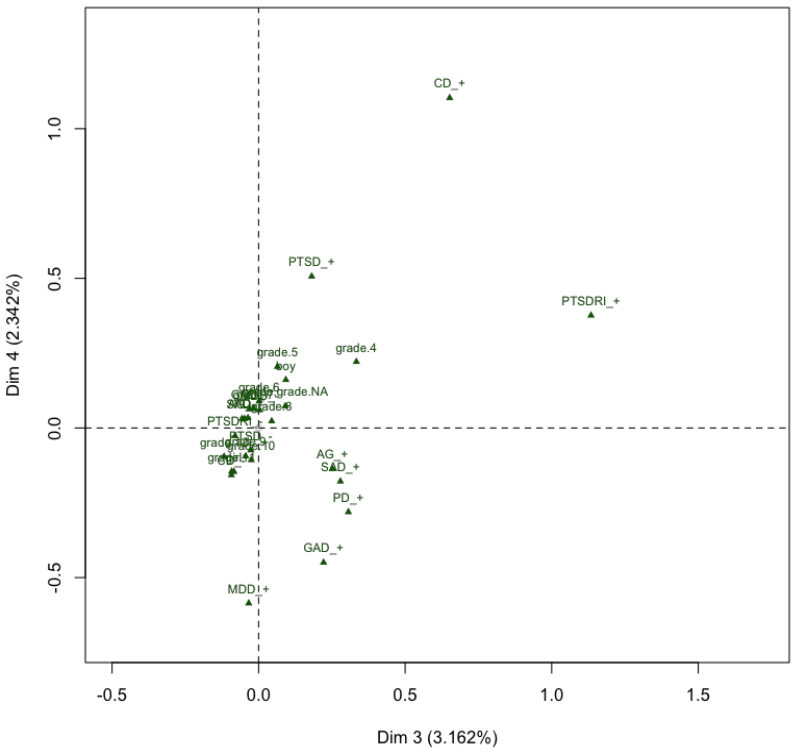

Figure 8. MCA factor map of dimension 3 and 4 with supplementary variables only.

4.4 Risk factors for PTSD and MDD

4.4.1 PTSD (assessed with the DPS)

Students were exposed to the WTC attack in different ways (Table 4): while only 3.8% reported that they were hurt in the attacks, more than 30% had to be evacuated from the building they were in for safety reasons. Interestingly, 7.6% reported that they personally witnessed the attack, by endorsing the following question: "I saw the planes crash or the towers collapse with my own eyes (in real life, not on television)". Almost 10% of students were in the cloud of smoke and dust that resulted from the collapse of the twin towers. More than 15% of the students had a family member that escaped unhurt from the WTC area, and 3.5% had at least a family member who died as a result of the attack. Interestingly, more than 6% of students reported being exposed a lot to 9/11 events through the web. While more than half the sample watched a lot of TV with adults, less than 10% of respondents was highly exposed to TV coverage without the presence of adults.

Table 4. Exposure variables

	Respondents		Missing	
Variables	**N**	**%**	**N**	**%**
Direct exposure				
Saw the planes	620	7.53	37	0.45
In the cloud of smoke	815	9.90	108	1.31
Physically hurt	310	3.76	113	1.37
Had to be evacuated	2545	30.90	210	2.55
Indirect exposure				
Family member escaped unhurt	1302	15.81		
Friend escaped unhurt	1999	24.27		
Family member hurt	321	3.90		
Friend hurt	674	8.18		
Family member died	291	3.53		
Friend died	1295	15.72		
Media exposure				
TV with adults	4136	50.22	305	3.70
TV without adults	745	9.05		
Web	529	6.42	304	3.69
Other media	2522	30.62	202	2.45

Table 5 presents results from the first set of multivariate logistic regressions (Step 1), with PTSD with and without impairment as the outcome. Among demographic variables, female gender and younger age are strong risk factors for PTSD. Every other multivariate logistic regression has been adjusted for the 5 demographic variables, regardless of the significance of the association between demographics and the outcome. As expected, direct exposure variables are associated with PTSD (with the exception of being in the cloud of smoke). Among other significant indirect exposure variables, it is worth pointing out the strong association between death of a family member and PTSD. To watch a lot of TV without adults is a significant risk factor for PTSD, while exposure to a lot of TV coverage of the WTC attack in the

presence of adults is not. Other types of media exposure are also strongly related to PTSD. Importantly, among all variables grief has the strongest association with PTSD. Another non exposure-related variable strongly associated with PTSD is family imposed restricted freedom to travel. Negative events that happened in the aftermath of the WTC attack (Difficulty getting home; smelled the smoke from WTC) are also significantly associated with PTSD. Finally, PTSD associated with experiences that interfered with the recovery environment in the 6 months following 9/11 (e.g., seeing anyone killed or seriously injured, family job loss and racism).

Table 5. First set of multivariate logistic regressions (Step 1)

	PTSD without impairment			**PTSD with impairment**		
Variables	**AOR**	**95% CI**	**p-value**	**AOR**	**95% CI**	**p-value**
Demographics						
Female	1.72	1.27; 2.34	0.0006	1.85	1.38; 2.50	0.0001
Grade=4-8	2.99	1.84; 4.87	0.0000	2.54	1.54; 4.19	0.0003
Black	1.14	0.53; 2.42	0.7381	1.09	0.48; 2.47	0.8310
Hispanic	1.63	0.89; 2.97	0.1133	1.51	0.80; 2.85	0.2068
Asian	1.11	0.70; 1.76	0.6630	1.17	0.74; 1.86	0.4948
Mixed/Other	1.82	0.91; 3.68	0.0919	1.39	0.50; 3.86	0.5239
<High School	1.05	0.70; 1.55	0.8206	1.17	0.82; 1.68	0.3804
Not live with both parents	0.88	0.63; 1.23	0.4463	0.98	0.64; 1.48	0.9099
Direct exposure						
Saw the planes	1.85	1.13; 3.00	0.0141	1.87	1.16; 3.02	0.0107
In the cloud of smoke	1.49	0.88; 2.52	0.1324	1.54	0.86; 2.76	0.1440
Physically hurt	2.06	1.03; 4.10	0.0402	2.28	1.11; 4.69	0.0259
Had to be evacuated	1.48	1.10; 1.99	0.0089	1.38	0.99; 1.90	0.0541
Indirect exposure						
Family member escaped unhurt	1.64	1.19; 2.25	0.0026	1.66	1.12; 2.45	0.0125
Friend escaped unhurt	1.14	0.83; 1.56	0.4068	1.15	0.80; 1.67	0.4449
Family member. hurt	1.50	0.81; 2.81	0.1971	1.52	0.85; 2.73	0.1586
Friend hurt	2.22	1.47; 3.35	0.0002	2.26	1.36; 3.75	0.0017
Family member died	2.18	1.22; 3.88	0.0084	2.24	1.12; 4.47	0.0222
Friend died	1.14	0.78; 1.66	0.4932	1.24	0.84; 1.85	0.2784
Media exposure						
TV with adults	1.32	0.98; 1.78	0.0722	1.33	0.91; 1.96	0.1386
TV without adults	1.98	1.16; 3.38	0.0128	2.11	1.08; 4.14	0.0301
Web	1.90	1.09; 3.32	0.0247	2.04	1.04; 4.01	0.0376
Other media	1.90	1.24; 2.90	0.0032	1.82	1.22; 2.71	0.0038
Grief	4.76	2.86; 7.92	0.0000	4.75	2.64; 8.56	0.0000
Exposure to other events before/after 9/11						
Badly hurt; before	1.24	0.82; 1.87	0.3029	1.39	0.89; 2.16	0.1489
Badly hurt; after	1.72	0.71; 4.16	0.2299	2.05	0.86; 4.84	0.1028
Badly hurt; before & after	0.55	0.05; 5.63	0.6120	0.81	0.08; 7.95	0.8572
Saw anyone killed or seriously injured; before	1.21	0.87; 1.68	0.2468	1.20	0.76; 1.88	0.4365
Saw anyone killed or seriously injured; after	2.78	1.63; 4.75	0.0002	3.01	1.71; 5.31	0.0002
Saw anyone killed or seriously injured; before & after	2.27	1.25; 4.14	0.0075	2.34	1.18; 4.66	0.0157
A close friend was badly hurt or killed; before	1.31	0.85; 2.02	0.2196	1.34	0.79; 2.30	0.2771
A close friend was badly hurt or killed; after	1.53	0.83; 2.81	0.1715	1.66	0.82; 3.35	0.1557
A close friend was badly hurt or killed; before & after	1.06	0.47; 2.39	0.8915	1.02	0.39; 2.65	0.9633
A family member was killed; before	1.24	0.87; 1.78	0.2258	1.34	0.93; 1.95	0.1189
A family member was killed; after	1.94	0.80; 4.73	0.1429	1.68	0.66; 4.26	0.2724
A family member was killed; before & after	0.91	0.18; 4.70	0.9074	1.12	0.20; 6.35	0.8971

Table 5 (continued). First set of multivariate logistic regressions (Step 1)

	PTSD without impairment			PTSD with impairment		
	AOR	**95% CI**	**p-value**	**AOR**	**95% CI**	**p-value**
Lived in a war area; before	1.41	0.74; 2.66	0.2912	1.41	0.72; 2.76	0.3085
Lived in a war area; after	1.46	0.47; 4.53	0.5147	1.82	0.56; 5.89	0.3186
Lived in a war area; before & after	0.98	0.21; 4.57	0.9789	1.34	0.29; 6.26	0.7045
In a big disaster; before	1.29	0.69; 2.43	0.4281	1.15	0.56; 2.38	0.7024
In a big disaster; after	2.15	0.89; 5.21	0.0896	2.22	0.91; 5.40	0.0789
In a big disaster; before & after	3.02	0.16; 58.08	0.4613	3.73	0.24; 58.27	0.3464
Difficulty getting home	1.77	1.22; 2.56	0.0027	1.77	1.10; 2.84	0.0189
Smelled the smoke from WTC	1.83	1.33; 2.52	0.0003	1.83	1.24; 2.69	0.0025
Life disruption						
Moved out of home	1.28	0.43; 3.85	0.6596	1.35	0.36; 5.14	0.6546
School closure	2.80	1.18; 6.64	0.0199	2.54	1.18; 5.48	0.0181
School relocation	1.05	0.31; 3.55	0.9323	1.50	0.46; 4.92	0.5045
Restricted travel	3.60	2.73; 4.74	0.0000	3.63	2.56; 5.15	0.0000
Family job loss	1.90	1.38; 2.60	0.0001	1.88	1.30; 2.72	0.0009
Racism	2.78	1.42; 5.46	0.0032	3.33	1.80; 6.16	0.0002
Friends' behaviors						
Drink more alcohol	1.43	0.35; 5.77	0.6171	1.10	0.22; 5.41	0.0952
Smoke more cigarettes	2.73	0.92; 8.07	0.0690	2.13	0.65; 7.04	0.2126
Talk more about suicide	2.76	0.84; 9.15	0.0954	3.30	0.98; 11.14	0.0540
Use more physical violence	1.24	0.41; 3.71	0.7012	1.77	0.62; 5.11	0.2862
Show more prejudice	2.04	1.09; 3.81	0.0262	2.13	1.11; 4.04	0.0229
Monitoring/attachment						
Parents rarely/never know where subject is	1.43	0.76; 2.69	0.2659	1.14	0.45; 2.89	0.7738
Subject rarely/never tell his/her parents about problems	0.82	0.53; 1.27	0.3709	1.03	0.59; 1.80	0.9082
Parents rarely/never ask about problems	1.05	0.56; 1.98	0.8673	1.00	0.53; 1.88	0.9942
Lack of support	0.97	0.70; 1.34	0.8411	0.99	0.63; 1.57	0.9743
Relatives' job						
≥1 FR in the family	1.26	0.82; 1.94	0.2917	1.22	0.83; 1.81	0.3110
Rescue/relief at the WTC	1.29	0.87; 1.90	0.2015	1.46	0.92; 2.30	0.1041
Works near WTC	1.33	1.02; 1.74	0.0343	1.37	1.02; 1.83	0.0346

Table 6 shows step 2a, step 3 and step 4 multivariate logistic regressions. Step 2a confirmed the finding of a strong association between death of a family member and PTSD. Step 3 shows the expected association between death of a family member and grief, adjusting for the same variables included in step 2a. Step 4 shows that when grief is introduced in the model, the association between death of a family member and PTSD becomes non-significant. Results from step 2b and 5 are not shown.

Table 7 presents the final model (step 6). In the unadjusted models, female gender and younger age are still strongly associated with PTSD. None of the direct exposure variables remained significant. Indirect 9/11 consequences, such as grief reactions to the death of family member, and having a friend who was hurt in the attack, remained significant predictors of PTSD. Media exposure through magazines, radio, and/or newspapers, and through TV (without adults) was still significant in the final model. Smelling the smoke coming from WTC is the only negative event that happened in the aftermath of the WTC attack that was still significant. Negative experiences that occurred in the 6 month after 9/11 to the respondent

Table 6. Grief as a mediator of the relationship between death of loved ones and PTSD

	Step 2a						**Step 3**			**Step 4**					
	PTSD without impair.			**PTSD with impairment**			**Grief**			**PTSD without impair.**			**PTSD with impairment**		
Variables	**AOR**	**95% CI**	**p-value**	**AOR**	**95% CI**	**p-value**	**AOR**	**95% CI**	**p-value**	**AOR**	**95% CI**	**p-value**	**AOR**	**95% CI**	**p-value**
Demographics															
Female	**1.74**	**1.27; 2.37**	**0.0006**	**1.89**	**1.36; 2.63**	**0.0002**	1.37	0.87; 2.17	0.1739	**1.71**	**1.23; 2.36**	**0.0014**	**1.85**	**1.32; 2.61**	**0.0005**
Grade=4-8	**3.03**	**1.80; 5.11**	**0.0000**	**2.52**	**1.53; 4.17**	**0.0004**	**2.52**	**1.32; 4.80**	**0.0053**	**2.88**	**1.71; 4.85**	**0.0001**	**2.38**	**1.44; 3.92**	**0.0008**
Black	1.32	0.62; 2.78	0.4675	1.26	0.56; 2.83	0.5790	1.39	0.64; 3.05	0.4063	1.29	0.61; 2.69	0.5028	1.22	0.54; 2.76	0.6234
Hispanic	1.70	0.94; 3.08	0.0778	1.56	0.82; 2.97	0.1739	1.45	0.71; 2.98	0.3090	1.66	0.93; 2.97	0.0889	1.51	0.80; 2.86	0.2003
Asian	1.32	0.77; 2.28	0.3136	1.38	0.80; 2.39	0.2465	0.66	0.26; 1.72	0.3952	1.35	0.77; 2.37	0.2896	1.41	0.81; 2.47	0.2269
Mixed/Other	**2.09**	**1.04; 4.22**	**0.0398**	1.53	0.52; 4.52	0.4429	1.06	0.32; 3.58	0.9195	**2.10**	**1.06; 4.17**	**0.0335**	1.53	0.52; 4.52	0.4393
<High School	1.08	0.69; 1.68	0.7500	1.22	0.81; 1.82	0.3372	0.87	0.45; 1.68	0.6855	1.09	0.70; 1.69	0.7004	1.24	0.83; 1.84	0.2936
Not live with both parents	0.85	0.60; 1.21	0.3667	0.94	0.62; 1.44	0.7884	0.81	0.54; 1.21	0.2961	0.87	0.61; 1.24	0.4332	0.97	0.64; 1.48	0.8855
Direct exposure															
Saw the planes	**1.75**	**1.06; 2.90**	**0.0297**	**1.79**	**1.08; 2.97**	**0.0251**	1.13	0.46; 2.79	0.7871	**1.75**	**1.07; 2.86**	**0.0251**	**1.79**	**1.10; 2.90**	**0.0190**
Physically hurt	1.74	0.89; 3.42	0.1059	1.94	0.95; 3.94	0.0673	1.64	0.58; 4.60	0.3469	1.69	0.86; 3.31	0.1250	1.88	0.91; 3.89	0.0897
Had to be evacuated	**1.43**	**1.05; 1.93**	**0.0213**	1.31	0.96; 1.79	0.0850	1.35	0.86; 2.10	0.1879	**1.39**	**1.01; 1.92**	**0.0426**	1.27	0.92; 1.77	0.1477
Indirect exposure															
Fam. memb. escaped unhurt	**1.60**	**1.13; 2.26**	**0.0077**	**1.63**	**1.07; 2.49**	**0.0234**	**2.53**	**1.54; 4.16**	**0.0003**	**1.46**	**1.02; 2.10**	**0.0398**	1.48	0.95; 2.32	0.0856
Friend hurt	**2.02**	**1.38; 2.97**	**0.0004**	**2.09**	**1.29; 3.39**	**0.0029**	**3.56**	**2.03; 6.26**	**0.0000**	**1.78**	**1.20; 2.63**	**0.0045**	**1.83**	**1.15; 2.92**	**0.0115**
Fam. memb. died	**2.07**	**1.19; 3.61**	**0.0104**	**2.12**	**1.17; 3.85**	**0.0140**	**14.86**	**7.99; 27.64**	**0.0000**	1.27	0.65; 2.51	0.4825	1.30	0.71; 2.38	0.3985
Media exposure															
TV with adults	1.33	0.99; 1.77	0.0565	1.35	0.94; 1.94	0.1079	1.16	0.71; 1.91	0.5493	1.32	0.98; 1.77	0.0632	1.34	0.93; 1.93	0.1139
TV without adults	**1.96**	**1.14; 3.37**	**0.0154**	**2.08**	**1.05; 4.13**	**0.0352**	1.29	0.62; 2.70	0.4918	**1.94**	**1.11; 3.38**	**0.0200**	**2.05**	**1.03; 4.08**	**0.0403**
Web	1.68	0.95; 2.94	0.0721	1.79	0.89; 3.60	0.1028	1.56	0.86; 2.83	0.1440	1.63	0.89; 3.00	0.1156	1.73	0.82; 3.67	0.1511
Other media	**1.72**	**1.12; 2.63**	**0.0131**	**1.62**	**1.09; 2.41**	**0.0178**	**1.89**	**1.20; 2.96**	**0.0062**	**1.65**	**1.06; 2.57**	**0.0282**	**1.55**	**1.04; 2.30**	**0.0310**
Grief										**3.12**	**1.77; 5.48**	**0.0001**	**3.02**	**1.68; 5.42**	**0.0003**

Table 7. Final model (Step 6): PTSD with and without impairment (adjusted and unadjusted for MDD)

	PTSD without impairment						PTSD with impairment					
	Unadjusted for MDD			Adjusted for MDD			Unadjusted for MDD			Adjusted for MDD		
Variables	**AORs**	**95% CI**	**p-value**	**AORs**	**95% CI**	**p-value**	**AORs**	**95% CI**	**p-value**	**AORs**	**95% CI**	**p-value**
Demographics												
Female	**1.64**	**1.18; 2.28**	**0.0034**	**1.54**	**1.11; 2.15**	**0.0111**	**1.80**	**1.24; 2.62**	**0.0022**	**1.65**	**1.12; 2.41**	**0.0110**
Grade=4-8	**2.65**	**1.68; 4.19**	**0.0000**	**2.84**	**1.79; 4.51**	**0.0000**	**2.11**	**1.33; 3.34**	**0.0017**	**2.31**	**1.46; 3.65**	**0.0004**
Black	1.17	0.59; 2.32	0.6449	1.20	0.61; 2.37	0.5971	1.12	0.50; 2.51	0.7874	1.16	0.51; 2.63	0.7243
Hispanic	1.56	0.89; 2.73	0.1191	1.53	0.87; 2.68	0.1369	1.41	0.74; 2.71	0.2974	1.37	0.70; 2.65	0.3528
Asian	1.14	0.62; 2.11	0.6684	1.10	0.58; 2.06	0.7726	1.18	0.64; 2.19	0.5882	1.12	0.60; 2.09	0.7118
Mixed/Other	1.73	0.89; 3.36	0.1054	1.77	0.89; 3.51	0.1022	1.21	0.37; 3.96	0.7529	1.24	0.36; 4.27	0.7310
<High School	1.07	0.69; 1.66	0.7627	1.05	0.66; 1.66	0.8329	1.20	0.80; 1.81	0.3751	1.17	0.75; 1.83	0.4781
Not live with both parents	0.89	0.62; 1.26	0.4995	0.86	0.62; 1.21	0.3863	0.98	0.63; 1.51	0.9130	0.94	0.63; 1.41	0.7698
Direct exposure												
Saw the planes	1.46	0.93; 2.30	0.0979	1.47	0.93; 2.31	0.0948	1.45	0.90; 2.35	0.1286	1.46	0.90; 2.38	0.1251
Indirect exposure												
Friend hurt	**1.63**	**1.05; 2.52**	**0.0295**	**1.59**	**1.02; 2.47**	**0.0417**	**1.68**	**1.01; 2.81**	**0.0467**	1.63	0.96; 2.77	0.0675
Media exposure												
TV with adults	1.29	0.94; 1.77	0.1080	1.26	0.91; 1.75	0.1628	1.28	0.85; 1.94	0.2302	1.24	0.80; 1.90	0.3307
TV without adults	**2.10**	**1.19; 3.73**	**0.0113**	**2.01**	**1.11; 3.61**	**0.0209**	**2.21**	**1.01; 4.85**	**0.0473**	2.06	0.91; 4.67	0.0833
Other media	**1.60**	**1.04; 2.46**	**0.0332**	**1.58**	**1.03; 2.40**	**0.0344**	**1.49**	**1.01; 2.18**	**0.0436**	**1.45**	**1.01; 2.08**	**0.0436**
Grief	**2.96**	**1.63; 5.37**	**0.0004**	**2.77**	**1.42; 5.41**	**0.0030**	**2.83**	**1.56; 5.15**	**0.0007**	**2.60**	**1.35; 5.03**	**0.0047**
Exposure to other events before/after 9/11												
Saw anyone killed/seriously injured; before	1.08	0.78; 1.52	0.6316	1.03	0.74; 1.44	0.8527	1.07	0.69; 1.66	0.7628	1.00	0.63; 1.58	0.9859
Saw anyone killed/seriously injured; after	**2.45**	**1.38; 4.33**	**0.0023**	**2.36**	**1.34; 4.16**	**0.0033**	**2.71**	**1.52; 4.83**	**0.0008**	**2.59**	**1.48; 4.55**	**0.0010**
Saw anyone killed/seriously injured; before & after	1.79	0.92; 3.49	0.0867	1.69	0.86; 3.34	0.1268	1.93	0.97; 3.83	0.0602	1.79	0.90; 3.57	0.0977
Difficulty getting home	1.42	0.99; 2.02	0.0542	1.37	0.96; 1.95	0.0793	1.37	0.89; 2.11	0.1459	1.30	0.97; 4.85	0.2157
Smelled the smoke from WTC	**1.36**	**1.00; 1.84**	**0.0478**	1.35	0.99; 1.82	0.0554	1.34	0.93; 1.93	0.1140	1.31	0.92; 1.88	0.1359
Life disruption												
Restricted travel	**3.07**	**2.27; 4.14**	**0.0000**	**2.97**	**2.22; 3.97**	**0.0000**	**3.02**	**2.04; 4.48**	**0.0000**	**2.89**	**1.97; 4.22**	**0.0000**
Family job loss	**1.57**	**1.13; 2.18**	**0.0075**	**1.57**	**1.12; 2.20**	**0.0089**	**1.52**	**1.03; 2.25**	**0.0372**	**1.53**	**1.05; 2.25**	**0.0289**
Racism	2.05	0.91; 4.65	0.0834	1.90	0.81; 4.44	0.1386	**2.40**	**1.13; 5.13**	**0.0236**	2.17	0.97; 4.85	0.0589
Friends' behaviors												
Talk more about suicide	**4.65**	**1.55; 13.99**	**0.0065**	**4.11**	**1.35; 12.49**	**0.0130**	**5.86**	**1.94; 17.72**	**0.0019**	**5.05**	**1.63; 15.66**	**0.0052**
MDD without impairment				**2.87**	**1.79; 4.59**	**0.0000**				**3.94**	**2.44; 6.37**	**0.0000**
R-Square for dependent variable	0.162185			0.172235			0.127453			0.143671		

(seeing anyone killed or seriously injured), to his/her family (family job loss), and related to friends' behaviors (friends talking a lot more about suicide), remained significant in the final model. Racism was associated only with PTSD with impairment. Reduced freedom to move around the city is the variable most strongly associated with PTSD in the final model. Importantly, all the significant variables remained significant or marginally significant after adjusting for MDD, showing that those variables are independent predictors of PTSD. Surprisingly, the association between grief and PTSD was almost unaffected after adjustment for MDD.

4.4.2 PTSD (assessed with the PTSD-RI)

Table 8 shows the final model (step 6) with PTSD-RI PTSD as the outcome. Several variables associated with PTSD-RI PTSD in the final model are the same variables that remained significant in the final model with DPS PTSD as the outcome. These variables include younger age, media exposure through magazines, radio, and/or newspapers, grief, seeing anyone killed or seriously injured after 9/11, restricted freedom to move around NYC and having friends talking a lot more about suicide.

Table 8. Final model (Step 6); PTSD-RI

	PTSD without impairment		
Variables	**ORs**	**95% CI**	**p-value**
Demographics			
Female	1.36	0.91; 2.04	0.1321
Grade=4-8	2.91	1.75; 4.84	0.0001
Black	0.64	0.20; 2.07	0.4498
Hispanic	1.11	0.42; 2.90	0.8373
Asian	0.99	0.37; 2.66	0.9840
Mixed/Other	1.53	0.43;5.46	0.5124
<High School	1.07	0.63; 1.81	0.8027
Not live with both parents	1.02	0.61; 1.70	0.9498
Media exposure			
Web	2.68	1.61; 4.48	0.0002
Other media	1.86	1.13; 3.05	0.0148
Grief	4.25	2.40; 7.55	0.0000
Exposure to other events before/after 9/11			
Badly hurt in a violent or accidental situation; before	1.25	0.79; 1.99	0.3446
Badly hurt in a violent or accidental situation; after	1.25	0.41; 3.77	0.6921
Badly hurt in a violent or accidental situation; before & after	0.05	0.01; 0.56	0.0150
Saw anyone killed or seriously injured; before	1.04	0.71;1.53	0.8431
Saw anyone killed or seriously injured; after	1.82	1.07; 3.10	0.0267
Saw anyone killed or seriously injured; before & after	2.07	0.82; 5.24	0.1220
Life disruption			
Restricted travel	3.18	2.05; 4.94	0.0000
Friends' behaviors			
Talk more about suicide	8.06	1.85; 35.11	0.0057
R-Square for dependent variable	0.106447		

In addition, similar to findings from DPS PTSD, items assessing direct exposure to the WTC attack were not significant in the final model. Also, like previous findings with DPS PTSD, grief was a mediator of the relationship between death of family members and PTSD-RI PTSD (data not shown). Unlike previous findings with DPS PTSD, media exposure through the web was significantly associated with PTSD-RI PTSD, but TV exposure (with and without adults) was not. In addition to seeing anyone killed or seriously injured after 9/11, another negative experiences that happened to the respondent after 9/11 was significantly associated with PTSD-RI PTSD (to be badly hurt in a violent or accidental situation, like a shooting or a car crash).

Traumatic grief reactions and especially negative friends' behaviors (having friends to move around the city is the variable most strongly associated with PTSD in the final model.

4.4.3 MDD

Table 9 shows the final model (step 6) with MDD as the outcome. In the models unadjusted for PTSD, female gender is the only demographic variable associated with MDD. None of the items assessing exposure to the WTC is associated with MDD in the final models. Grief reactions to the death of a loved one and restricted freedom to move around the city are associated with MDD, like in models predicting PTSD. Also, grief mediated the relationship between death of a family member and death of a fiend and MDD (data not shown). Importantly, unlike previous results with PTSD as the outcome, the strength and significance of the association between those variables and MDD was considerably influenced by the introduction of PTSD in the adjusted models. Surprisingly, the association between grief and PTSD was almost unaffected after adjustment for MDD. For example, the relationship between restricted freedom to travel around the city and MDD with impairment became only marginally significant. Surprisingly, the relationship between grief and MDD without impairment was considerably reduced after adjustment for PTSD. It should be noted that, although the introduction of PTSD in the model reduced the significance of the association between MDD and its predictors, all the variables remained significan or mariginally significant.

4.5 PTSD symptom structure

4.5.1 PTSD symptom profiles in the whole sample and across gender, age and age by gender groups

The epidemiology of DPS PTSD items, exposure and DPS PTSD probable diagnosis is summarized in Table 10. First, LCA models were fit to 8 DPS PTSD symptoms reported by trauma-exposed subjects (n = 6,733). A four-class model best fitted the data (see the "Methods" for model fit criteria). Figure 9 (panel A) presents the patterns of response probability profiles for each of the four classes. Classes differ quantitatively, as reflected by the progressive increase of symptom's profile severity from class 1 to class 4, obtained by summing each symptom conditional probability within a class.

Table 9. Final model (Step 6): MDD with and without impairment (adjusted and unadjusted for PTSD)

Variables	MDD without impairment						MDD with impairment					
	Unadjusted for PTSD			Adjusted for PTSD			Unadjusted for PTSD			Adjusted for PTSD		
	AORs	95% CI	p-value	AORs	95% CI	p-value	AORs	95% CI	p-value	AORs	95% CI	p-value
Demographics												
Female	**1.89**	**1.39; 2.57**	**0.0001**	**1.80**	**1.32; 2.47**	**0.0003**	**1.88**	**1.35; 2.61**	**0.0002**	**1.79**	1.28; 2.5	**0.0007**
Grade=4-8	0.76	0.49; 1.16	0.2023	0.71	0.46; 1.09	0.1130	0.73	0.46; 1.15	0.1736	0.68	0.43; 1.08	0.0993
Black	0.99	0.59; 1.65	0.9546	0.98	0.59; 1.63	0.9426	1.06	0.59; 1.92	0.8358	1.06	0.6; 1.89	0.8384
Hispanic	1.36	0.88; 2.1	0.1718	1.31	0.85; 2	0.2177	1.34	0.8; 2.23	0.2657	1.29	0.79; 2.12	0.3101
Asian	1.42	0.71; 2.86	0.3187	1.44	0.72; 2.88	0.3011	1.44	0.68; 3.08	0.3423	1.46	0.69; 3.1	0.3210
Mixed/Other	0.96	0.41; 2.25	0.9234	0.91	0.37; 2.2	0.8290	0.86	0.33; 2.27	0.7616	0.82	0.3; 2.21	0.6876
<High School	1.16	0.81; 1.66	0.4165	1.14	0.78; 1.66	0.4990	1.21	0.81; 1.8	0.3563	1.18	0.78; 1.8	0.4328
Not live with both parents	1.14	0.74; 1.74	0.5532	1.13	0.75; 1.72	0.5594	1.12	0.72; 1.76	0.6123	1.12	0.72; 1.73	0.6131
Indirect exposure												
Friend hurt	1.37	0.84; 2.26	0.2096	1.26	0.77; 2.07	0.3479	1.42	0.85; 2.39	0.1772	1.32	0.79; 2.19	0.2881
Media exposure												
Other media	1.32	0.89; 1.97	0.1678	1.24	0.84; 1.85	0.2809	1.4	0.93; 2.11	0.1042	1.32	0.88; 2	0.1812
Grief	**2.27**	**1.3; 3.98**	**0.0044**	1.83	0.97; 3.46	0.0604	**2.44**	**1.4; 4.26**	**0.0018**	**1.98**	**1.07; 3.68**	**0.0304**
Exposure to other events before/after 9/11												
Saw anyone killed/seriously injured; before	1.42	0.98; 2.08	0.0670	1.39	0.96; 2.02	0.0776	1.39	0.93; 2.07	0.1031	1.36	0.92; 2.01	0.1198
Saw anyone killed/seriously injured; after	1.83	0.96; 3.51	0.0681	1.57	0.83; 2.97	0.1636	**2**	**1.03; 3.89**	**0.0401**	1.73	0.91; 3.3	0.0966
Saw anyone killed/seriously injured; before & after	1.7	0.79; 3.65	0.1760	1.51	0.69; 3.32	0.3038	1.7	0.75; 3.84	0.2008	1.52	0.65; 3.52	0.3285
Difficulty getting home	1.31	0.92; 1.87	0.1310	1.24	0.87; 1.75	0.2362	1.28	0.86; 1.88	0.2179	1.20	0.81; 1.78	0.3580
Smelled the smoke from WTC	**1.42**	**1.01; 2.01**	**0.0461**	1.36	0.97; 1.92	0.0762	**1.48**	**1.05; 2.09**	**0.0264**	**1.42**	1.01; 2	**0.0459**
Life disruption												
Restricted travel	**1.72**	**1.23; 2.41**	**0.0016**	**1.45**	**1.03; 2.05**	**0.0348**	**1.72**	**1.19; 2.49**	**0.0039**	1.46	1; 2.13	0.0517
Racism	1.99	1.02; 3.87	0.0423	1.78	0.88; 3.59	0.1057	2.06	0.99; 4.29	0.0546	1.84	0.86; 3.98	0.1178
Monitoring/attachment												
Subject rarely/never tell parents about problems	1.62	0.97; 2.71	0.0634	**1.65**	**1; 2.73**	**0.0491**	**1.69**	**1.03; 2.78**	**0.0388**	**1.72**	**1.06; 2.78**	**0.0282**
Friends' behaviors												
Smoke more cigarettes	**2.99**	**1.38; 6.46**	**0.0057**	**2.45**	**1.07; 5.57**	**0.0332**	**3.33**	**1.49; 7.42**	**0.0035**	**2.74**	**1.17; 6.43**	**0.0209**
Show more prejudice	**1.92**	**1.1; 3.33**	**0.0218**	**1.89**	**1.06; 3.37**	**0.0318**	1.84	0.98; 3.43	0.0565	1.81	0.94; 3.47	0.0740
PTSD (without impairment)				**2.86**	**1.76; 4.65**	**0.0000**				**2.78**	1.69; 4.57	**0.0001**
R-Square for dependent variable	0.060601			0.072085			0.060422			0.070419		

In particular, class 1 (50% of subjects) is characterized by little disturbance, with low probabilities of symptoms endorsement, except recurrent thoughts, which is the most prevalent symptom in each class. Class 2 and 3 (23% and 17% of subjects, respectively) exhibit intermediate disturbance; members report an average of 3.2 and 2.9 symptoms, respectively.

Table 10. DPS-PTSD items and Exposure to 9/11

DPS-PTSD Item	**Freq. (%)**
B. Re-experiencing	
D1 (Recurrent thoughts)	6209 (75.39)
D3 (Nightmares)	1306 (15.86)
C. Avoidance and Numbing	
D4 (Avoid thinking)	3375 (40.98)
D5 (Avoid activities/places)	1270 (15.42)
D6 (Avoid people)	1094 (13.28)
D7 (Foreshortened future)	1200 (14.57)
D. Increased arousal	
D2 (Insomnia)	1877 (22.79)
D8 (Difficulty concentrating)	2130 (25.86)
Direct, Indirect, and Media Exposure to 9/11	**Freq. (%)**
Direct Exposure	620 (7.53)
Personally witnessed the attack (saw the planes crash or the towers collapse in real life)	815 (9.90)
Physically hurt in the attack	310 (3.76)
In or near the cloud of dust and smoke	2545 (30.90)
Evacuated to safety	
Indirect Exposure	
Any family member* escaped unhurt	1302 (15.81)
A friend or someone else known by the child escaped unhurt	1999 (24.27)
Any family member hurt	321 (3.90)
A friend or someone else known by the child hurt	674 (8.18)
Any family member died	2.91 (3.53)
A friend or someone else known by the child died	1295 (15.72)
Media Exposure: a lot of time spent learning about the attack from:	
TV	4881 (59.26)
Web sites	529 (6.42)
Radio, newspapers, or magazines	2522 (30.62)
Trauma exposed individuals	**6,733 (82.00)****

*Mother, father, stepmother, stepfather, foster mother, foster father, sister, brother, grandmother, grandfather, aunt, uncle or other family member.
**Final sample used for LCA.

Class 2 is qualified by sleep related symptoms, while class 3 is qualified by avoidance symptoms. Class 4 (10% of subjects), whose members report over 5.9 symptoms on average, is qualified by severe disturbance. The prevalence of probable diagnoses of PTSD across classes corresponded to the levels of severity within each class (Table 11).

The 4 classes differ also qualitatively (Table 11). Compared to the intermediate disturbance classes (class 2 and 3), the ORs of symptom endorsement of class 4 (severe disturbance) vs. either one of the intermediate disturbance classes were all significantly greater than 1, ranging from 2.56 to 56.38, with the only exception of foreshortened future in the comparison between class 4 and class 3 (OR = 0.61). Class 4

and 2 differ from class 3 for the higher probability of reporting sleep related symptoms; Class 4 and 3 differ from class 2 for the higher probability of reporting symptoms of avoidance. Consequently, configurational differences between the two intermediate disturbance classes consisted in higher conditional probabilities mostly for symptoms of re-experiencing and arousal related to sleep problems in

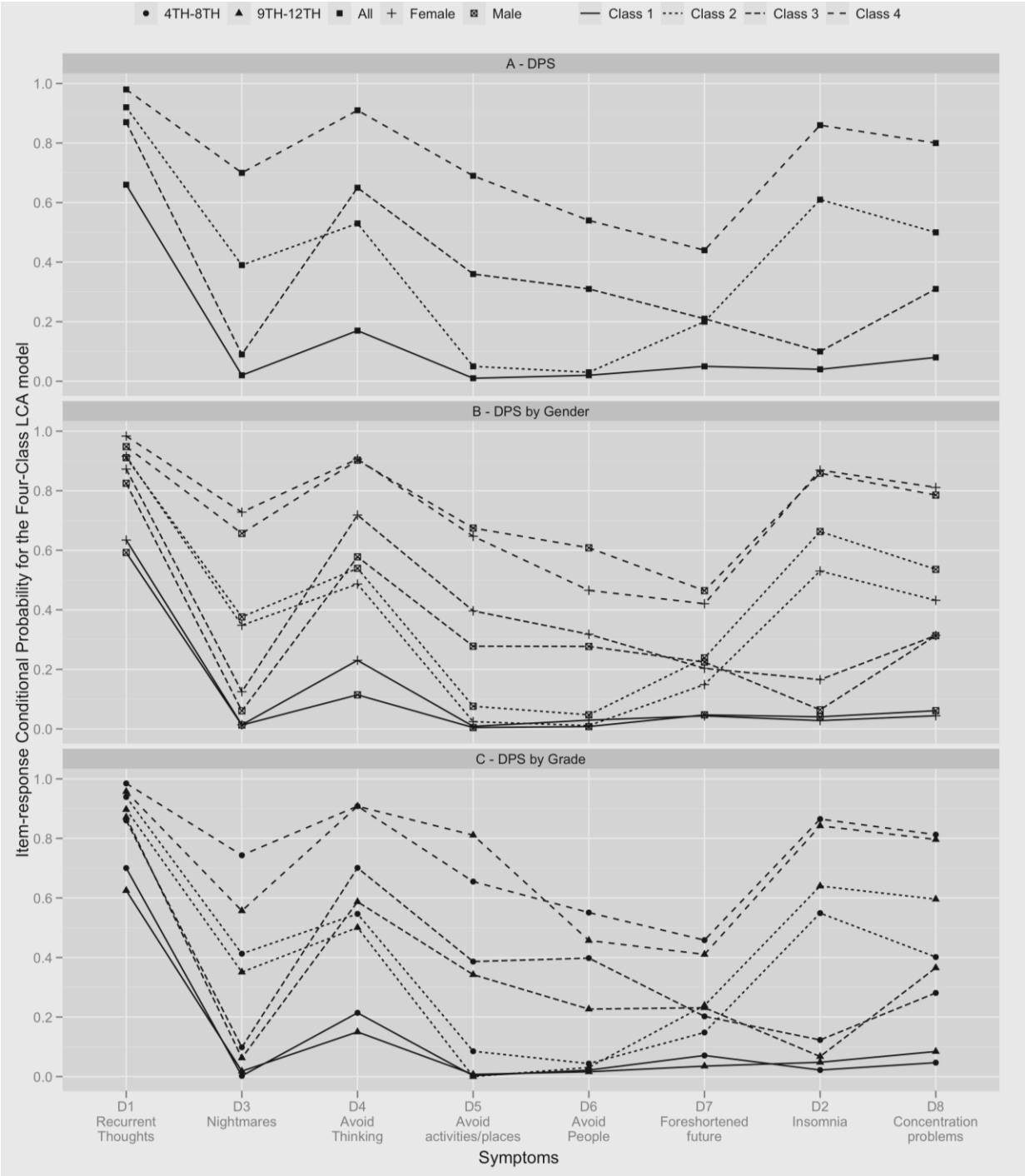

Figure 9. Estimated response probability profiles for the 4-class best fitting model of LCA on DPS-PTSD symptoms in the whole sample (panel A), in the sample stratified by gender (panel B), in the sample stratified by Age (4^{TH}-8^{TH} grades; panel C).

Table 11. Conditional Probabilities of DPS PTSD symptoms and relative odds of symptom endorsement of Class 4 (Severe Disturbance) compared to Class 3 (Intermediate Disturbance with avoidance symptoms) and Class 2 (Intermediate Disturbance with sleep-related problems), and of Class 3 compared to Class 2 and Class 2 to Class 3.

	Conditional probabilities				Class 4 vs. Class 3	Class 4 vs. Class 2	Class 3 vs. Class 2	Class 2 vs. Class 3
	Class 1	Class 2	Class 3	Class 4	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Estimated class population shares	0.49	0.19	0.21	0.11				
Predicted class membership	0.54	0.18	0.17	0.10				
B. Re-experiencing								
D1 (Recurrent thoughts)	0.66	0.92	0.87	0.98	7.19 (4.11-13.57)	4.08 (2.29-7.79)	0.57 (0.43-0.75)	1.76 (1.34-2.33)
D3 (Nightmares)	0.02	0.39	0.09	0.70	22.41 (17.19-29.28)	3.57 (2.91-4.38)	0.16 (0.13-0.20)	6.28 (4.97-7.97)
C. Avoidance and Numbing								
D4 (Avoid thinking)	0.17	0.53	0.65	0.91	5.35 (3.98-7.27)	8.74 (6.53-11.83)	1.63 (1.38-1.93)	0.61 (0.52-0.72)
D5 (Avoid activities/places)	0.01	0.05	0.36	0.69	3.98 (3.23-4.91)	39.26 (28.99-53.42)	9.86 (7.47-13.12)	0.10 (0.08-0.13)
D6 (Avoid people)	0.02	0.03	0.31	0.54	2.56 (2.1-3.13)	41.42 (28.32-61.92)	16.16 (11.19-23.93)	0.06 (0.04-0.09)
D7 (Foreshortened future)	0.05	0.20	0.21	0.44	3.01 (2.43-3.72)	0.61 (0.51-0.73)	1.09 (0.89-1.34)	0.09 (0.06-0.14)
D. Increased arousal								
D2 (Insomnia)	0.04	0.61	0.10	0.86	56.38 (41.69-76.32)	4.07 (3.16-5.28)	0.07 (0.06-0.09)	13.84 (11.03-17.42)
D8 (Concentration problems)	0.08	0.50	0.31	0.80	8.91 (7.06-11.26)	4.04 (3.22-5.07)	0.45 (0.38-0.54)	2.21 (1.86-2.62)
Sum of conditional probabilities	1.03	3.25	2.91	5.93				

Abbreviations: OR, odds ratios

class 2, compared to class 3; the odds of reporting nightmares and insomnia for members of class 2 compared to class 3 are 6.28 and 13.84, respectively. Compared to class 2, members of class 3 show higher overall prevalence of avoidance symptoms, especially avoidance of activities and/or places, and avoidance of people; the odds of reporting these two items for members of class 3 vs. class 2 are 9.86 and 16.16, respectively. To further characterize the initial four-class model, we stratified the sample according to gender, age, and gender by age (<13; ≥13). A four-class model best fitted the data also in the stratified samples. PTSD symptoms profiles across gender and age groups are overall similar to the ones obtained in the whole sample (Figure 9 panel B and C). Gender-related differences in symptoms profiles are bolstered when stratified by age (Figure 10, panel A and B). The symptoms profiles of boys and girls in the 4^{th}-8^{th} grades group were not significantly different between each other. Girls older than 13 years old (i.e. 9^{th}-12^{th} grades) were more likely to report a more severe profile in each of the four latent classes than boys in the same age range. In particular, in the pervasive disturbance class girls have, on average, 6.05 symptoms, with the avoidance cluster representing 39% of the total; boys have 5.31 symptoms, on average, with the avoidance cluster representing 32% of the total. In the intermediate disturbance class characterized by sleep-related problems, girls have on average 3.41 symptoms, compared to an average of 2.47 in boys. In terms of class membership, girls have a higher risk of belonging to the pervasive disturbance class (class 4: 12.8% girls vs. 6.5% boys) and to the intermediate class characterized by avoidance symptoms (class 3: 23% girls vs. 13% boys); no class membership differences were observed for the intermediate disturbance class defined by sleep-related problems (Class 2: 20% girls vs. 23% boys). To specifically identify the symptoms that show differential reporting by gender by age groups, we estimated the OR of the symptoms conditional probabilities between girls and boys profiles within each class (Table 12). In the pervasive disturbance class, the OR of the probability of reporting avoidance of activities/places is significantly greater for females than males. In the intermediate disturbance class characterized by avoidance symptoms (class3), girls are instead more likely to report insomnia (D2). In the intermediate disturbance class characterized by sleep-related problems (class 2), females are more likely to endorse nightmares (D3), insomnia (D2) and avoidance of thoughts (D4).

4.5.2 Individual profiles of trauma exposure

In an effort to reduce heterogeneity of exposure to 9/11-related events and identify subgroups of subjects with similar patterns of exposure to 9/11-related potentially traumatic events, LCA was conducted on the items assessing direct, indirect and media exposure to the WTC attack. Comparison of BIC reveals that the 6-class model (BIC = 85,767.63; $\chi 2$ = 52,302.82) has the best fit in the whole sample. However, since the BIC screeplot showed the sharpest drop of BIC values for the 3-class model, meaning that an addition of more classes does not explain much additional variation, the 3-class solution was selected as the most parsimonious description of exposure to 9/11-related potentially traumatic events. Class 1 (33% of

Table 12. Odds Ratios (ORs) and relative 95% CIs of the comparison of LCA Conditional Probabilities of PTSD symptoms across Exposure Types, Gender, and Age

	Class4		Class 3		Class 2	
4th – 8th Grades; Girls vs. Boys	**OR (95% CI)**	***P* value**	**OR (95% CI)**	***P* value**	**OR (95% CI)**	***P* value**
Re-experiencing						
D1 (Recurrent thoughts)	5.32 (1.6719.79)	0.0015	3.66 (2.05-6.88)	<0.001	1.83 (0.92-3.87)	0.0458
D3 (Nightmares)	0.89 (0.59-1.35)	0.3072	2.30 (1.54-3.45)	<0.001	1.37 (0.99-1.89)	0.0284
Avoidance and Numbing						
D4 (Avoid thinking)	1.17 (0.63-2.25)	0.3585	1.39 (1.02-1.91)	0.0191	1.39 (1.01-1.91)	0.0199
D5 (Avoid activities/places)	1.14 (0.78-1.67)	0.2675	1.40 (1.03-1.89)	0.0149	9.66 (4.19-25.84)	<0.001
D6 (Avoid people)	1.68 (1.16-2.44)	0.0028	1.47 (1.10-1.98)	0.0048	3.18 (1.28-8.63)	0.0052
D7 (Foreshortened future)	1.27 (0.88-1.82)	0.1108	1.12 (0.78-1.60)	0.2860	2.97 (1.88-4.73)	<0.001
Increased arousal						
D2 (Insomnia)	0.75 (0.45-1.27)	0.1501	2.52 (1.61-4.02)	<0.001	1.30 (0.95-1.78)	0.0526
D8 (Concentration prob.)	0.76 (0.49-1.20)	0.1291	0.96 (0.70-1.32)	0.4301	1.43 (1.04-1.97)	0.0130
9th – 12th Grades; Girls vs. Boys						
Re-experiencing						
D1 (Recurrent thoughts)	1.72 (0.36-8.92)	0.3222	0.84 (0.48-1.44)	0.2993	22.27 (13.42-38.18)	<0.001
D3 (Nightmares)	1.72 (0.93-3.18)	0.0427	1.53 (0.73-3.46)	0.1562	5.23 (3.50-7.88)	<0.001
Avoidance and Numbing						
D4 (Avoid thinking)	2.84 (1.06-8.12)	0.0184	1.52 (1.03-2.23)	0.0176	2.35 (1.70-3.26)	<0.001
D5 (Avoid activities/places)	∞	<0.001	0.99 (0.67-1.46)	0.5108	1.42 (0.40-5.19)	0.3604
D6 (Avoid people)	1.21 (0.66-2.24)	0.3007	0.90 (0.59-1.37)	0.3314	7.38 (0.88-340.24)	0.0362
D7 (Foreshortened future)	1.31 (0.71-2.44)	0.2177	0.97 (0.62-1.53)	0.4870	0.97 (0.66-1.41)	0.4649
Increased arousal						
D2 (Insomnia)	15.75 (2.36-663.74)	<0.001	∞	<0.001	2.90 (2.09-4.04)	<0.001
D8 (Concentration problems)	1.07 (0.50-2.29)	0.5003	0.97 (0.66-1.44)	0.4739	1.16 (0.84-1.60)	0.1895
Indirect vs. Direct Exposure						
Re-experiencing						
D1 (Recurrent thoughts)	1.13 (0.21-7.47)	0.58	∞	<0.001	15.01 (4.86-74.95)	<0.001
D3 (Nightmares)	1.44 (0.77-2.72)	0.14	22.41 (6.49-117.46)	<0.001	5.70 (3.82-8.51)	<0.001
Avoidance and Numbing						
D4 (Avoid thinking)	∞	0.0003	1.17 (0.59-2.32)	0.37	3.84 (2.63-5.62)	<0.001
D5 (Avoid activities/places)	2.90 (1.57-5.47)	0.0002	1.26 (0.69-2.29)	0.25	∞	<0.001
D6 (Avoid people)	2.95 (1.68-5.21	<0.001	0.97 (0.51-1.85)	0.52	3.26 (1.31-8.19)	0.005
D7 (Foreshortened future)	1.45 (0.83-2.52)	0.10	1.46 (0.76-2.80)	0.14	1.28 (0.83-1.96)	0.1424
Increased arousal						
D2 (Insomnia)	∞	0.001	∞	0.03	13.09 (8.12-21.56)	<0.001
D8 (Concentration problems)	2.29 (1.08-5.12)	0.01	0.74 (0.411.35)	0.18	2.08 (1.43-3.04)	<0.001
Media vs. Direct Exposure						
Re-experiencing						
D1 (Recurrent thoughts)	0.37 (0.05-2.81)	0.21	∞	<0.001	2.97 (0.87-15.66)	0.05
D3 (Nightmares)	1.87 (1.07-3.33)	0.01	7.58 (4.26-13.35)	<0.001	2.03 (1.41-2.94)	0.0001
Avoidance and Numbing						
D4 (Avoid thinking)	∞	0.001	1.73 (1.01-3.03)	0.02	1.34 (0.93-1.95)	0.06
D5 (Avoid activities/places)	1.40 (0.79-2.57)	0.14	1.69 (1.04-2.73)	0.01	3.84 (2.22-6.65)	<0.001
D6 (Avoid people)	1.62 (0.97-2.71)	0.03	0.97 (0.58-1.61)	0.51	2.03 (0.88-4.54)	0.05
D7 (Foreshortened future)	1.05 (0.64-1.71)	0.47	1.93 (1.14-3.20)	0.01	1.61 (1.03-2.50)	0.02
Increased arousal						
D2 (Insomnia)	∞	<0.001	∞	0.0017	5.32 (3.36-8.68)	<0.001
D8 (Concentration problems)	1.96 (0.98-4.22)	0.03	2.42 (1.49-3.93)	0.0001	2.32 (1.59-3.39)	<0.001

Abbreviations: n.a., not available

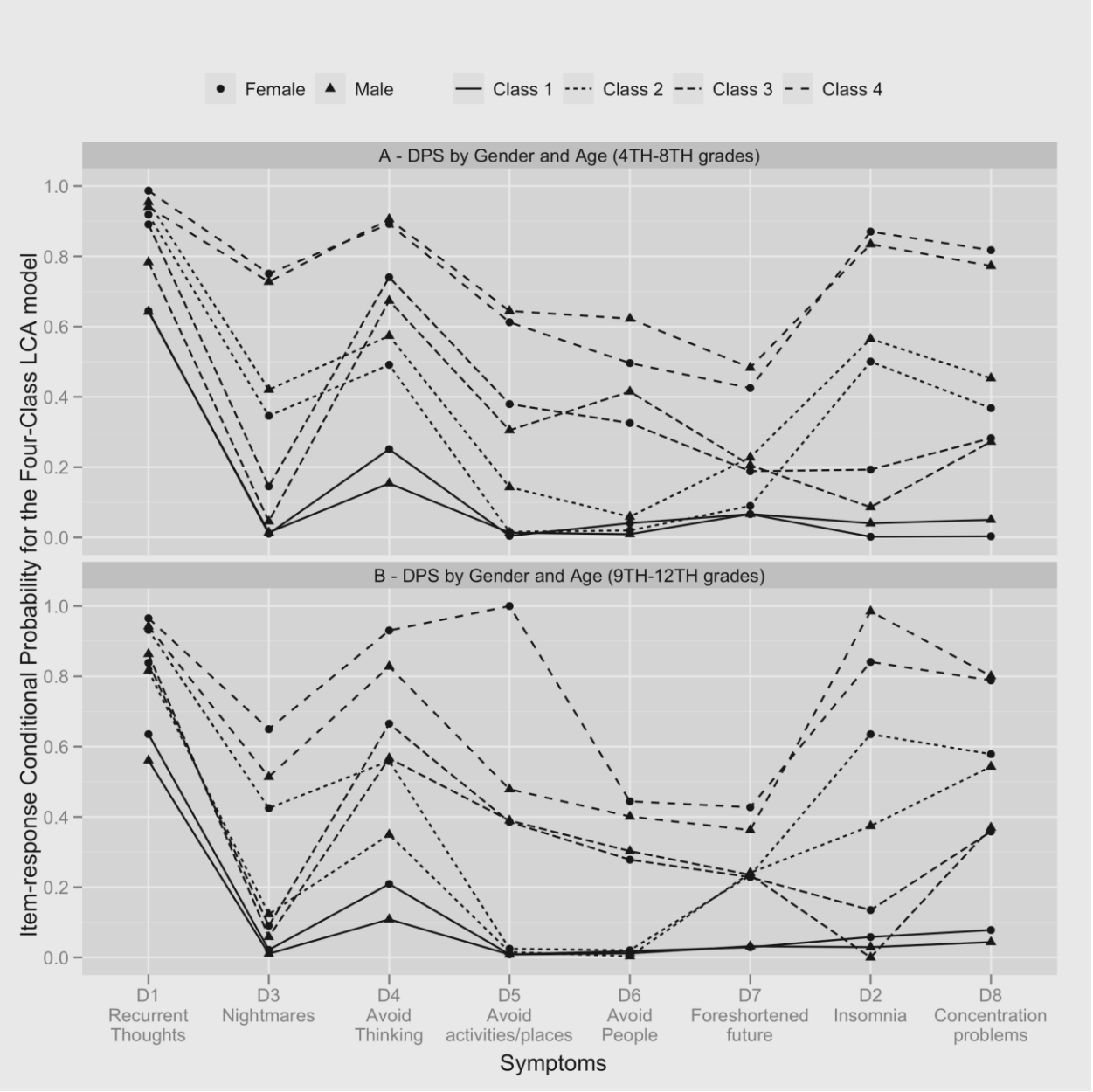

Figure 10. Estimated response probability profiles for the 4-class best fitting model of LCA on DPS-PTSD symptoms in the sample stratified by gender and age groups (4^{TH}-8^{TH} grades; panel A) and (9^{TH}-12^{TH} grades; panel B).

subjects) grouped individuals with high probability of having experienced direct exposure events, with the exception of being physically hurt, which showed low probabilities across classes. Class 2 (26% of subjects) grouped individuals who displayed high probabilities of exposure to 9/11 through the media. Class 3 (41% of subjects) was representative of individuals with relatively low probability of having experienced media exposure, especially when compared to Class 2, and high probability of reporting

indirect exposure, mainly by learning about trauma experienced by a loved one. Thus, the 3 classes were labeled as “Direct Exposure” (Class 1), “Media Exposure” (Class 2), and “Indirect Exposure” (Class 3).

To examine if the latent structure of PTSD varies across empirically defined subgroups characterized by different patterns of exposure, LCA models were compared across the three exposure latent classes (Figure 11). The 4-class solution was the best fitting in each subgroup, with class-profiles overall consistent with those identified by the initial LCA in the whole sample. Compared to the “Direct Exposure” subgroup, the odds of the conditional probability of PTSD symptoms in the “Indirect Exposure” subgroup were higher for the following items: D4, D5, D6 (Avoidance) and D2 (Insomnia) in the pervasive disturbance class, D1 and D3 (Re-experiencing) in the intermediate disturbance class defined by avoidance symptoms, and all symptoms except D6 and D2 in the intermediate disturbance class defined by sleep-related problems. Compared to the “Media Exposure” subgroup, the odds of the conditional probabilities of PTSD symptoms in the “Indirect Exposure” subgroup were higher for the following items: D4 and D2 (Avoidance of thoughts and insomnia, respectively) in the pervasive disturbance class, D1, D3 (Re-experiencing) and D8 (Difficulty concentrating) in the intermediate disturbance class defined by avoidance symptoms, and all symptoms except D1, D6 and D7 in the intermediate disturbance class defined by sleep-related problems (Table 12).

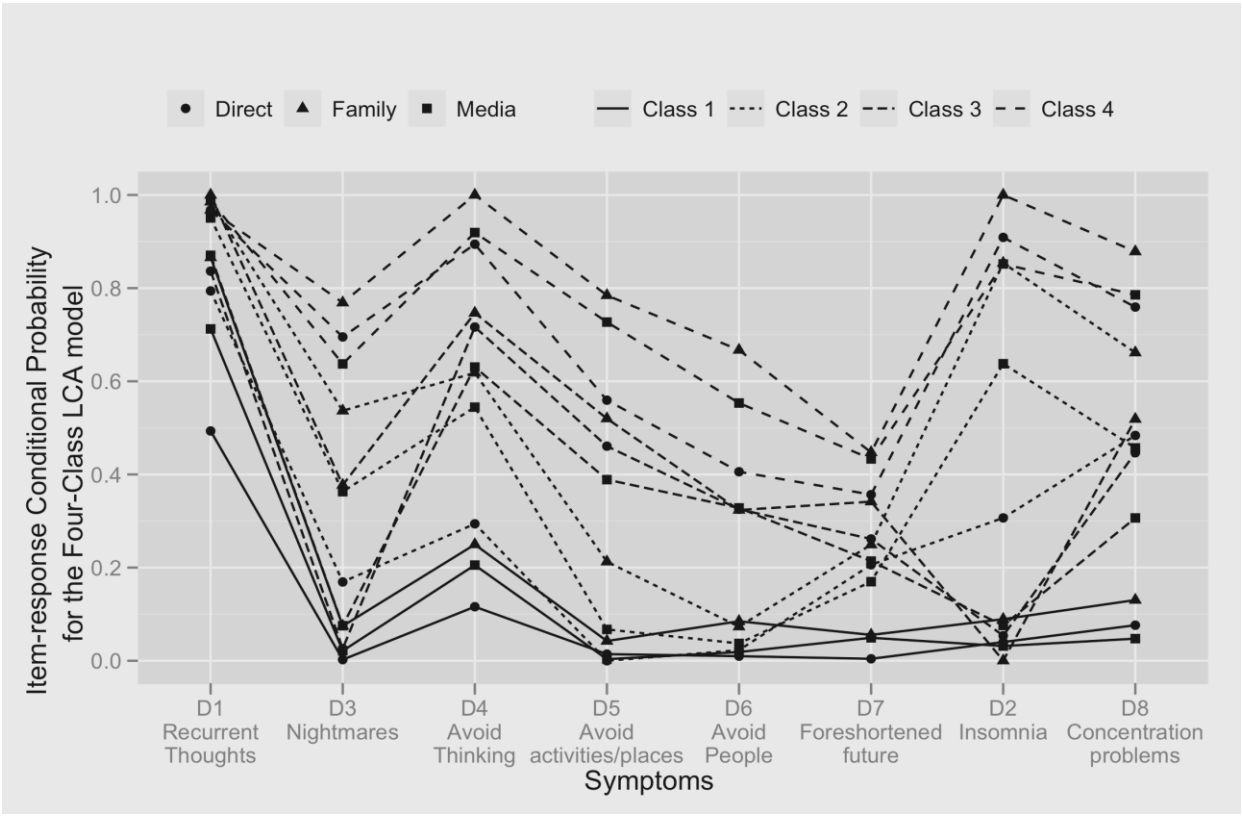

Figure 11. Estimated response probability profiles for the 4-class best fitting model of LCA on DPS-PTSD symptoms across the three subgroups/classes of trauma exposure empirically defined by the LCA on exposure variables.

Based on the differences in DPS symptom profiles across genders and age subgroups, as revealed by LCA, we used a latent class regression model including age and gender as covariates to predict individual latent class membership across exposure-subgroups (Figure 12). Across exposure types, girls tended to have higher risk of belonging to the severe and intermediate disturbance classes, and lower probability of belonging to the little distress class. These differences in probability of latent class membership between boys and girls decrease with increasing age. Differences in probabilities of latent class membership profiles seem to be more attributable to gender and age than to exposure subgroups.

4.5.3 Individual profiles of DPS-PTSD symptoms and functional impairment indicators

To investigate the relationship between PTSD symptom profiles and indicators of distress and functional impairment, LCA models were fit to the 8 DPS-PTSD symptoms and 7 impairment indicators, starting with a two-class model, increasing the number of classes up to six. The 5-class was the best fitting model based on BIC criteria and interpretability (Figure 13). A low disturbance class, two classes of intermediate disturbance, (with sleep-related and avoidance symptoms, respectively), and a severe disturbance class can still be identified. The inclusion of impairment variables does not influence the response probability profiles for each of the four classes revealed by the initial LCA, but generates a fifth class with an intermediate level of PTSD severity and high level of impairment; in this class, the sum of

Table 13. Logistic regressions predicting risk of other DPS disorders in the 5 latent classes defined by DPS PTSD symptoms and impairment indicators

	OR (SE)	95% CI	z	*P* value
Conduct Disorder				
Class 1	0.51 (0.04)	0.44-0.59	-9.13	0.00
Class 2	0.73 (0.08)	0.59-0.91	-2.83	0.01
Class 3	0.86 (0.09)	0.70-1.07	-1.37	0.17
Class 4	1.68 (0.19)	1.35-2.09	4.60	0.00
Class 5	3.74 (0.34)	3.14-4.46	14.71	0.00
Separation Anxiety				
Class 1	0.14 (0.01)	0.12-0.16	-22.78	0.00
Class 2	1.28 (0.11)	1.08-1.53	2.79	0.01
Class 3	2.27 (0.19)	1.92-2.67	9.81	0.00
Class 4	8.97 (0.83)	7.47-10.76	23.59	0.00
Class 5	1.27 (0.13)	1.04-1.55	2.36	0.02
Major Depression				
Class 1	0.17 (0.02)	0.14-0.21	-17.10	0.00
Class 2	0.83 (0.10)	0.65-1.04	-1.60	0.11
Class 3	1.33 (0.14)	1.07-1.64	2.61	0.01
Class 4	4.89 (0.50)	4.00-5.97	15.54	0.00
Class 5	3.71 (0.36)	3.07-4.49	13.46	0.00
Generalized Anxiety				
Class 1	0.22 (0.02)	0.19-0.26	-17.93	0.00
Class 2	0.83 (0.09)	0.68-1.02	-1.75	0.08
Class 3	1.89 (0.17)	1.58-2.25	7.03	0.00
Class 4	4.55 (0.44)	3.77-5.48	15.80	0.00
Class 5	2.44 (0.23)	2.03-2.94	9.45	0.00

Abbreviations: OR, odds ratios; SE, standard error; CI, confidence interval.

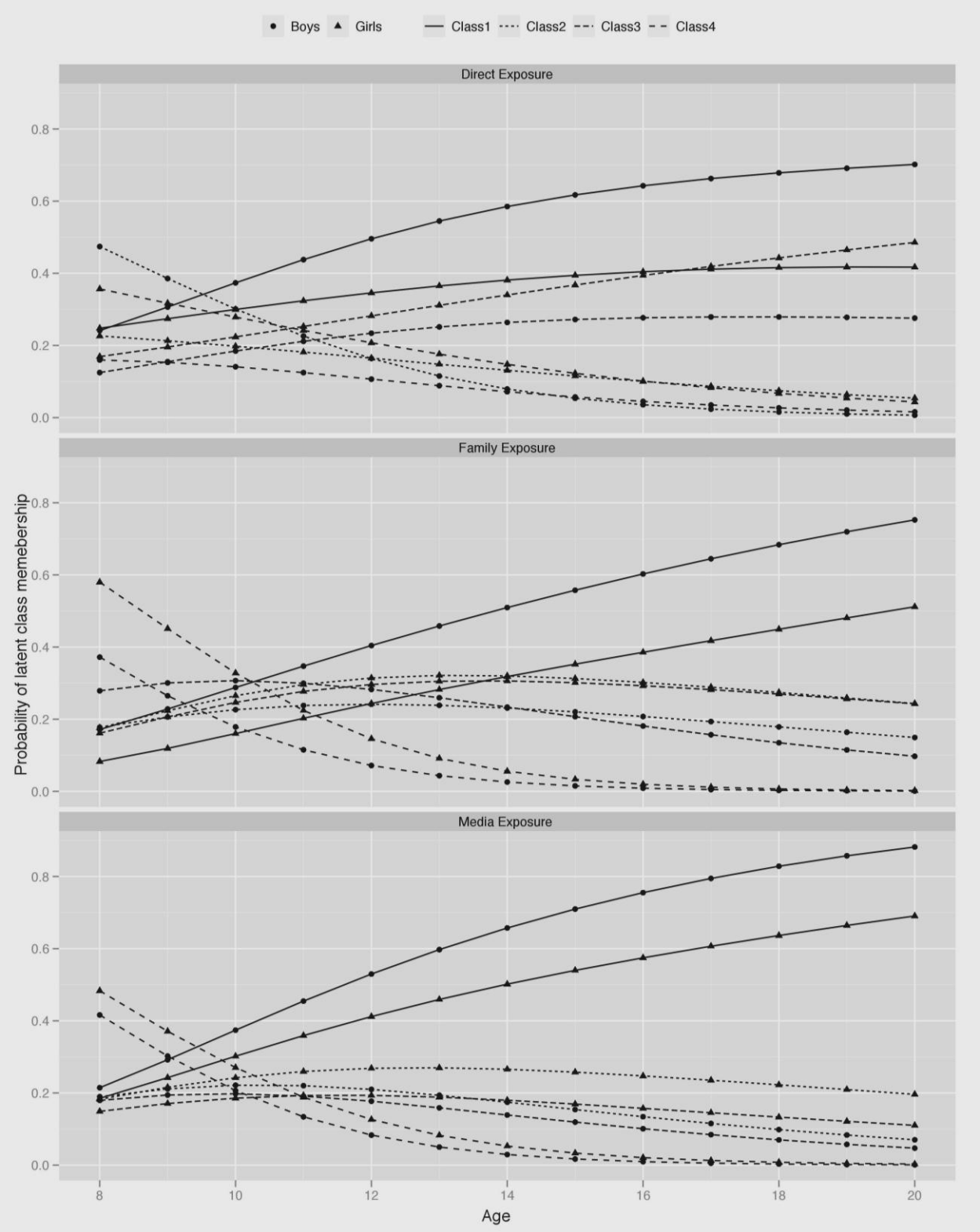

Figure 12. Predicted prior probabilities of latent class membership at increasing age by genders across the three subgroups/classes of trauma exposure empirically defined by the LCA on exposure variables. Results are from a 4-class latent class regression model.

conditional probabilities of PTSD symptoms and impairment indicators was on average 2.19 and 2.57, respectively. In the other four classes, only members of the severe PTSD disturbance class also displayed a severe profile of functional impairment, with a sum of impairment indicators' conditional probabilities of 2.12, on average. The 2 other intermediate disturbance classes and the little distress class had sums of conditional probabilities of impairment indicators lower than 1. To explain the high degree of functional impairment in the fifth class characterized by intermediate PTSD disturbance, we looked at the prevalence of other three probable disorders (MDD, SAD and CD). Rates of probable MDD, SAD and CD were particularly high in the class characterized by severe PTSD disturbance and high levels of impairment, and in the fifth class showing intermediate PTSD disturbance combined with high levels of impairment, compared to the other classes (Table 13). In particular, members of the intermediate PTSD disturbance with high levels of impairment class had significant higher rates of probable CD (OR = 3.7) than any other classes.

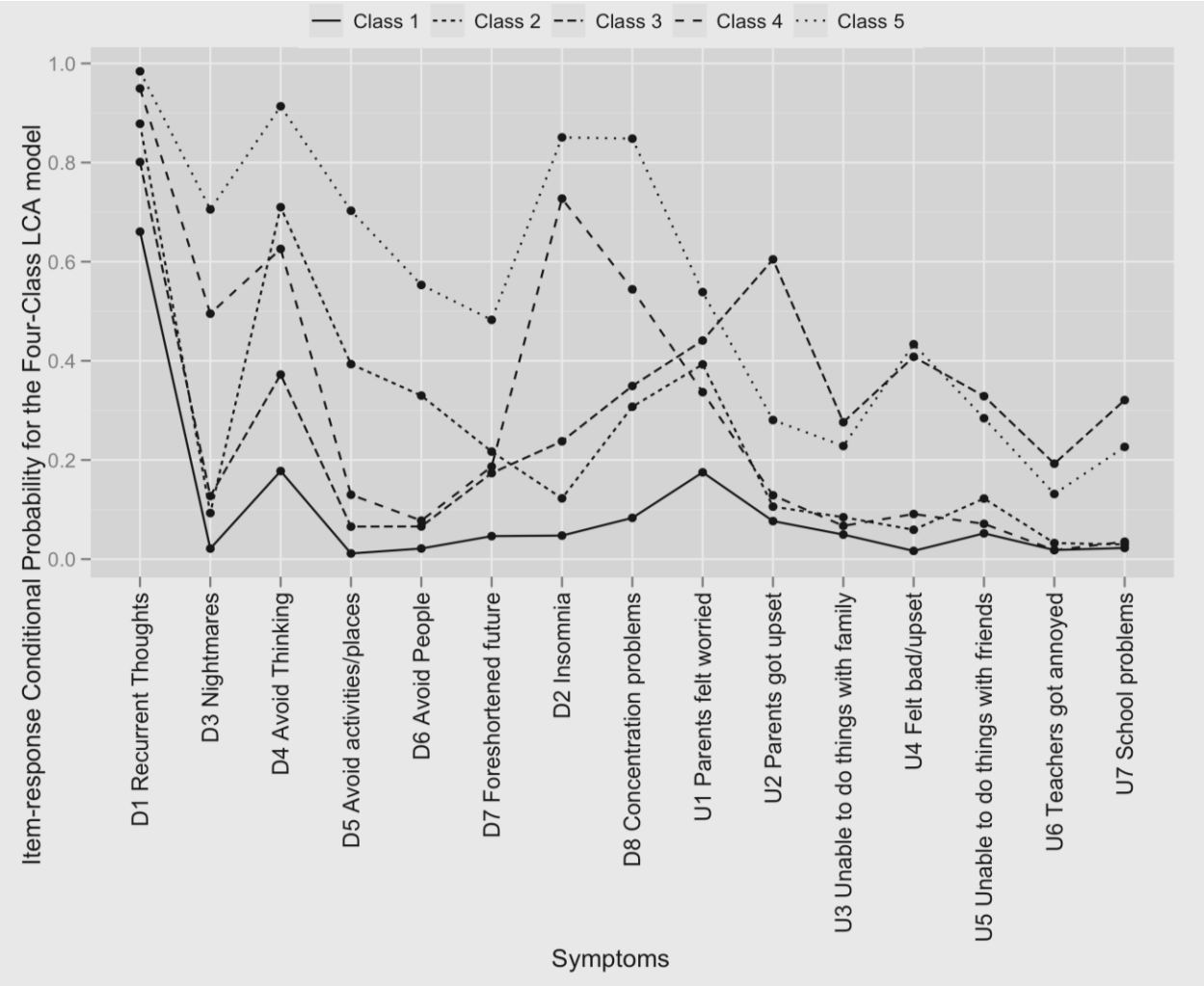

Figure 13. Estimated response probability profiles for the 5 classes of DPS PTSD symptoms and impairment indicators in the whole sample.

4.6 Comorbidity

Comorbidity frequencies (and bivariate associations) for the 7 disorders assessed with the DPS (PTSD, SAD, GAD, AG, PD, MDD), for PTSD assessed with the PTSD-RI, and for problem drinking are reported in Table 3. PTSD (DPS) is highly comorbid with SAD (50.86% of PTSD cases) and AG (50.86% and 60.13% of PTSD cases, respectively). On the contrary, the co-occurrence of PTSD and CD, and PTSD and problem-drinking (two externalizing phenotypes) is less frequent (15.73% and 5.59%, respectively) and not significant.

4.6.1 A systematic evaluation of PTSD and comorbid symptomatology

The goal of the following analysis was to examine the aggregation of PTSD and co-occurring psychiatric symptoms assessed by the DPS screening scale in the whole population-based sample of children and adolescents. Comorbid conditions add another layer of complexity to the PTSD clinical phenotype. An initial latent class analysis (LCA) was used to characterize the underlying structure of DPS symptoms present in the sample. A second set of LCA was conducted to examine the differential symptoms profiles across gender and age groups. Using the 52 DPS symptoms, a six-class solution was found to best fit the data and explain the underlying structure of DPS probable disorders for the over 8,000 subjects with complete information on all symptoms. Figure 14 shows the symptom endorsement probabilities for each latent class. DPS symptoms are along the horizontal axis of the figure, and probability of symptom endorsement for each class is indicated along the vertical axis.

Classes differ quantitatively, as reflected by the progressive increase of symptom's profile severity across the 6 classes, obtained by summing each symptom conditional probability within a class. In particular, the classes may be described as consisting in three severe disturbance classes, clustering internalizing and externalizing symptoms respectively, and a third severe disturbance class that clusters anxious misery symptoms, two intermediate disturbance classes, and a class consisting of children and adolescents who endorsed few or no DPS symptoms. The class of low or no disturbance contained 29% of the sample, with the two intermediate classes containing 21% and 20%, in order of higher prevalence. The prevalence of the remaining three severe disturbance classes was smaller, with 8% of individuals in the internalizing symptoms class, 5% in the externalizing symptoms class and 13% in the anxious misery symptoms class.

In terms of symptom configuration, classes identify four different main symptoms cluster: internalizing and anxious misery classes, comprising both severe and intermediate disturbance profiles, an externalizing class, and a low or no disturbance class. In particular, Class 3 is consistent with a severe disturbance profile of internalizing symptoms, recording higher conditional probability for symptoms of PTSD, SAD, AGO, PD, GAD and MDD, as also reflected by the prevalence of these disorders in the class (Table 14). Members of class 6 are characterized by pervasive distress, with high conditional probabilities for symptoms of generalized anxiety disorder (GAD) and depression (MDD), which may be

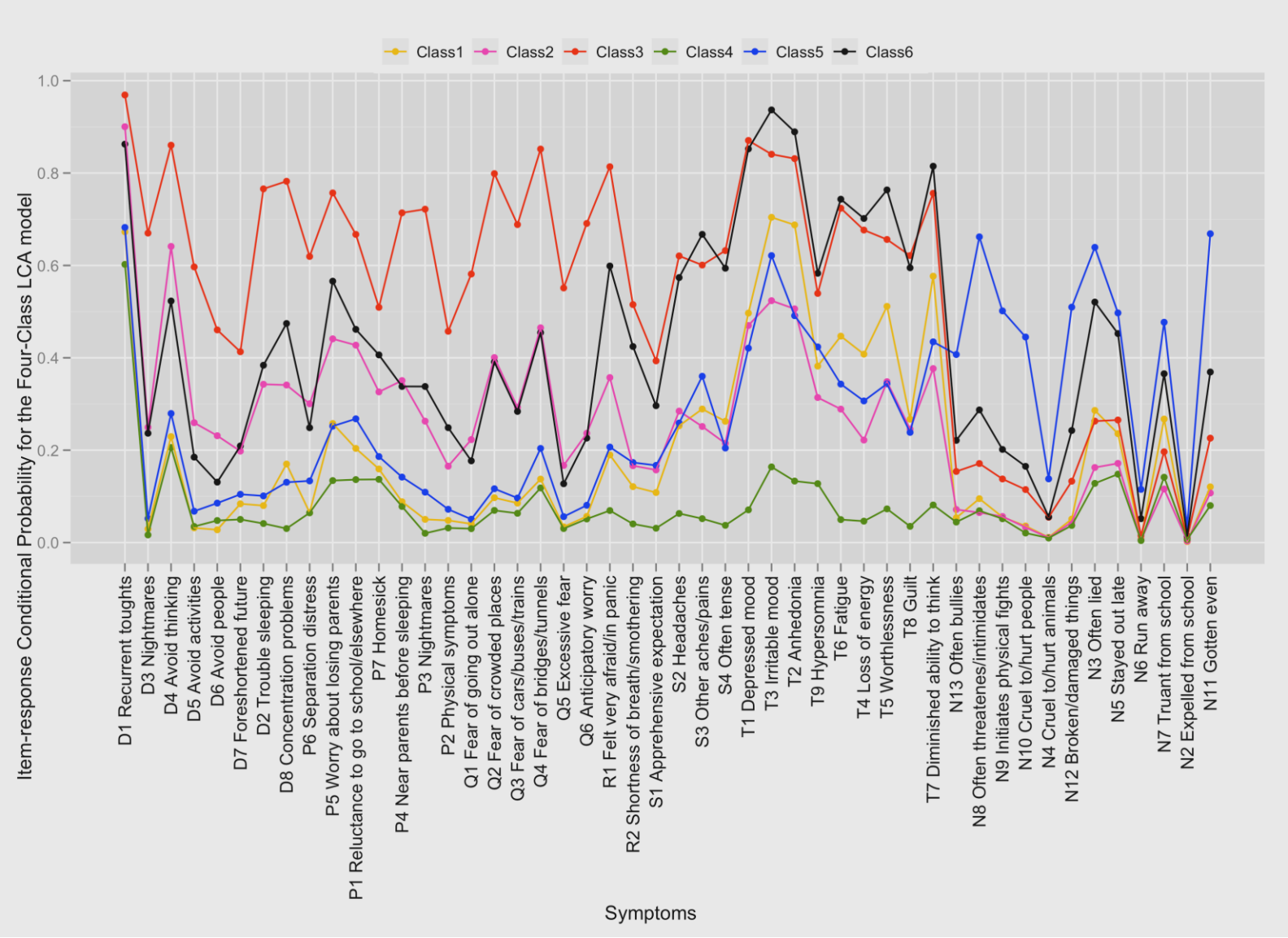

Figure 14. Estimated response probability profiles for the 6-class best fitting model of LCA on DPS psychopathological symptoms in the whole sample.

comprehensively described by an anxious-misery factor (Table 15). Overall, members of this class show a profile of intermediate disturbance with respect to other internalizing symptoms, including those of PTSD, SAD, AGO and PD. Nevertheless, the PTSD symptoms of "concentration problems", "problems falling and/or staying asleep", and "avoid thinking" show higher conditional probabilities with respect to the rest of symptoms of avoidance or re-experiencing. This evidence may further support the qualification of this class as an anxious-misery symptom profile. The high conditional probabilities recorded for symptoms of conduct disorder may represent in this class the reflection of the phenotypic manifestation of the mood problems that characterize the anxious misery factor. Class 5 is characterized by severe externalizing disturbance, with high conditional probabilities of conduct disorder symptoms endorsement (Table 16). MDD symptoms show high conditional probability, especially for the "irritable mood" symptom. The latter may be in fact consistent with the overall characterization of the symptoms profile in the direction of the identification of an externalizing factor. MDD prevalence in this class is not very high, which seems to exclude that MDD symptoms in this class may have clinical relevance from a diagnostic point of view. Class 1 and class 2 exhibit an intermediate level of disturbance characterized by the same symptom configuration of anxious-misery and internalizing severe disturbance classes respectively.

Table 14. Internalizing class in the whole sample and in the 4 subgroups defined by age and gender.

	Whole sample	**Girls 8-13**	**Boys 8-13**	**Gilrs 14-21**	**Boys 14-21**
Total number of observations	8236	2146	1785	2148	2111
Predicted class memberships	0.0847	0.2404	0.107	0.0945	0.0696
Class size	698	516	191	203	147
	N (%)	N (%)	N (%)	N (%)	N (%)
DPS PTSD	533 (76.36)	155 (30.04)	133 (69.64)	117 (57.64)	62 (42.18)
PTSD-RI PTSD	335 (47.99)	199 (38.57)	87 (45.55)	61 (30.05)	34 (23.13)
SAD	523 (74.93)	139 (26.94)	125 (65.45)	130 (64.04)	55 (37.41)
AGO	622 (89.11)	162 (31.40)	144 (75.39)	174 (85.71)	66 (44.90)
PD	314 (44.99)	91 (17.64)	52 (27.23)	103 (50.74)	49 (33.33)
GAD	296 (42.41)	73 (14.15)	67 (35.08)	112 (55.17)	73 (49.66)
MDD	233 (33.38)	60 (11.63)	32 (16.75)	115 (56.65)	74 (50.34)
CD	110 (15.76)	7 (1.36)	6 (3.14)	49 (24.14)	85 (57.82)
ALC	23 (3.30)	0 (0.00)	3 (1.57)	19 (9.36)	26 (17.69)
Impairment = 0	137 (19.63)	32 (6.20)	44 (23.04)	26 (12.81)	29 (19.73)
Impairment = 1	204 (29.23)	45 (8.72)	55 (28.80)	59 (29.06)	28 (19.05)
Impairment = 2	168 (24.07)	37 (7.17)	48 (25.13)	60 (29.56)	39 (26.53)
Impairment >= 3	175 (25.07)	48 (9.30)	39 (20.42)	56 (27.59)	44 (29.93)
Direct exposure	161 (23.07)	30 (5.81)	35 (18.33)	82 (40.39)	61 (41.50)

Table 15. Anxious-misery class in the whole sample and in the 4 subgroups defined by age and gender.

	Whole sample	Girls 8-13	Boys 8-13	Girls 14-21	Boys 14-21
Total number of observations	8236	2146	1785	2148	2111
Predicted class memberships	0.1349	0.0774	0.0936	0.1732	0.1497
Class size	1111	166	167	372	316
	N (%)	N (%)	N (%)	N (%)	N (%)
DPS PTSD	161 (14.49)	65 (39.16)	47 (28.14)	50 (13.44)	5 (1.58)
PTSD-RI PTSD	90 (8.10)	38 (22.89)	27 (16.17)	29 (7.80)	4 (1.27)
SAD	316 (28.44)	119 (71.69)	77 (46.11)	72 (19.35)	11 (3.48)
AGO	281 (25.29)	126 (75.90)	59 (35.33)	60 (16.13)	15 (4.75)
PD	327 (29.43)	81 (48.80)	52 (31.14)	95 (25.54)	41 (12.97)
GAD	442 (39.78)	95 (57.23)	59 (35.33)	131 (35.22)	61 (19.30)
MDD	428 (38.52)	78 (46.99)	39 (23.35)	125 (33.60)	103 (32.59)
CD	387 (34.83)	110 (66.27)	95 (56.89)	16 (4.30)	80 (25.32)
ALC	87 (7.83)	9 (5.42)	3 (1.80)	17 (4.57)	26 (8.23)
Impairment = 0	236 (21.24)	32 (19.28)	30 (17.96)	106 (28.49)	94 (29.75)
Impairment = 1	327 ()29.43	49 (29.52)	50 (29.94)	132 (35.48)	87 (27.53)
Impairment = 2	265 (23.85)	50 (30.12)	34 (20.36)	68 (18.28)	80 (25.32)
Impairment >= 3	248 (22.32)	52 (31.33)	43 (25.75)	60 (16.13)	43 (13.61)
Direct exposure	347 (31.23)	24 (14.46)	26 (15.57)	148 (39.78)	173 (54.75)

Table 16. Externalizing class in the whole sample and in the 4 subgroups defined by age and gender.

	Whole sample	Girls 8-13	Boys 8-13	Girls 14-21	Boys 14-21
Total number of observations	8236	2146	1785	2148	2111
Predicted class memberships	0.0572	0.2404	0.0896	0.0633	0.0772
Class size	471	516	160	136	163
	N (%)	N (%)	N (%)	N (%)	N (%)
DPS PTSD	10 (2.12)	4 (0.78)	3 (1.88)	3 (2.21)	0 (0.00)
PTSD-RI PTSD	6 (1.27)	3 (0.58)	0 (0.00)	0 (0.00)	1 (0.61)
SAD	20 (4.25)	27 (5.23)	6 (3.75)	26 (19.12)	3 (1.84)
AGO	20 (4.25)	23 (4.46)	4 (2.50)	29 (21.32)	3 (1.84)
PD	37 (7.86)	42 (8.14)	11 (6.88)	29 (21.32)	3 (1.84)
GAD	31 (6.58)	51 (9.88)	15 (9.38)	43 (31.62)	11 (6.75)
MDD	14 (2.97)	28 (5.43)	6 (3.75)	28 (20.59)	0 (0.00)
CD	423 (89.81)	68 (13.18)	126 (78.75)	120 (88.24)	141 (86.50)
ALC	47 (9.98)	6 (1.16)	11 (6.88)	26 (19.12)	20 (12.27)
Impairment = 0	156 (33.12)	134 (25.97)	49 (30.63)	29 (21.32)	67 ()41.10
Impairment = 1	120 (25.48)	111 (21.51)	38 (23.75)	40 (29.41)	44 (26.99)
Impairment = 2	90 (19.11)	51 (9.88)	30 (18.75)	31 (22.79)	21 (12.88)
Impairment >= 3	75 (15.92)	43 (8.33)	25 (15.63)	32 (23.53)	24 (14.72)
Direct exposure	108 (22.93)	28 (5.43)	9 (5.63)	48 (35.29)	57 (34.97)

4.6.2 PTSD and comorbid symptoms profiles across gender and gender by age groups

To further characterize the initial six-class model, we stratified the sample according to gender and gender by age (<13; ≥13). The same six-class model was found to best fit the data also in the stratified samples, which eased the evaluation of differences of specific class profiles across subgroups with respect to the

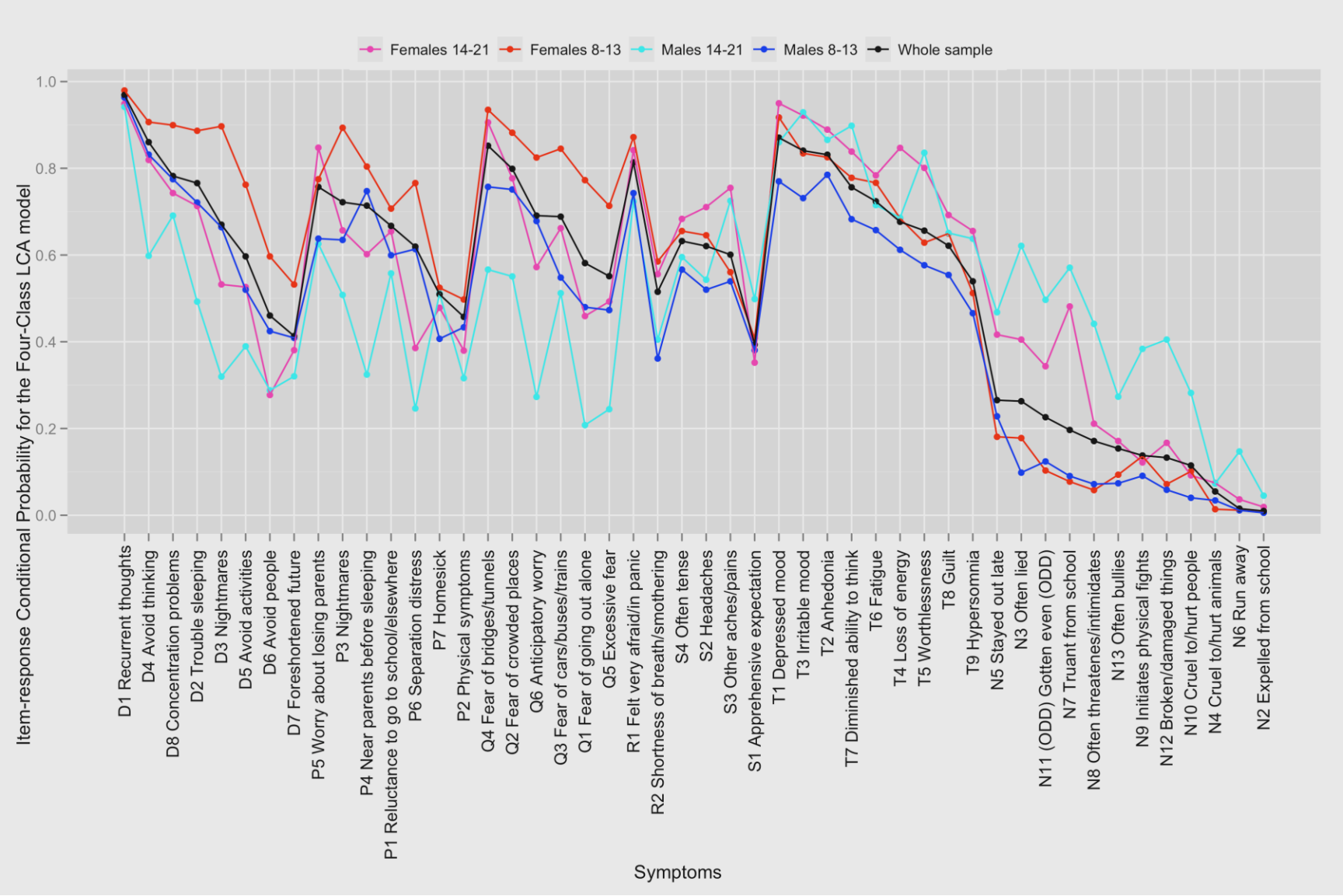

Figure 15. Estimated response probability profiles for the internalizing class in the whole sample and in the sample stratified by gender and age groups.

reference profile originated by the initial LCA on the whole sample. Comparing the symptom profile for each single class, we see that a large part of the difference from the original profile of LCA on the whole sample is associated both with gender and age.

Figure 15 shows that young girls in the age range between 8-13 years old represent the group that overall is most likely to report symptoms of the internalizing disorders PTSD, SAD, AGO, and PD, and less likely to report symptoms of GAD, MDD and CD. When compared to the profiles of older girls in the age range between 14-21 years old, and also to either the symptoms profile of young or old boys, the widest gaps is displayed for symptoms of sleep problems (D2-Trouble sleeping, D3 Nightmares, P3 nightmares), separation distress (P6 Separation distress), and fear (Q6 Anticipatory worry, Q3 Fear of cars/buss/trains, Q1 Fear of going out alone, and Q5 Excessive fear) in the presence of pervasive internalizing disturbance class. The gap is particularly significant when the young girls profile for these symptoms is compared with that of boys in the age range between 14-21 years old. Girls in the age range of 14-21 years old are more likely to report symptoms of GAD, MDD and CD when compared to the symptoms profile of the other three groups. Similar pattern can be identified for the symptoms profile of boys in the age range between 14-21 years old. In particular, this is the group that is most likely to report symptoms of externalizing disorders in the internalizing class, although the conditional probabilities of the respective symptoms are overall in the range of values characteristic of intermediate disturbance. The symptoms profile of boys in the age range between 8-13 years old is the most similar to the reference profile of the whole sample.

Figure 16 shows the symptoms profile of the four genders by age subgroups in the anxious-misery class. The four subgroups consistently show higher conditional probabilities for the symptoms of MDD and SAD, with the only exception for the boys in the age range between 14-21 years old in correspondence of the SAD symptoms, which are overall low. The stratified analysis also allows highlighting the differential pattern of SAD, AGO and PD symptoms endorsement across age groups regardless of the genders. Boys and girls in the age range between 8-13 years old are more likely to report internalizing severe disturbance than girls and boys in the age range between 14-21 years old. This is still true when comparing PTSD symptoms conditional probabilities, even if the gap is less significant.

Figure 17 shows that girls in the age range between 14-21 years old are more likely to report MDD and CD symptoms and less likely to report internalizing symptoms, although the conditional probabilities of the symptoms are still the highest when compared to the other subgroups. The MDD symptom of “irritable mood” is the most frequent symptom endorsed by either young or older girls. Overall, girls are more likely than boys to report MDD symptoms. Young and older boys are more likely to report CD symptoms, with the highest conditional probability reported for the CD symptoms of aggressive behavior toward people and/or animals (N12 Often threatens/intimidates), and the symptom of ODD (N11 Gotten

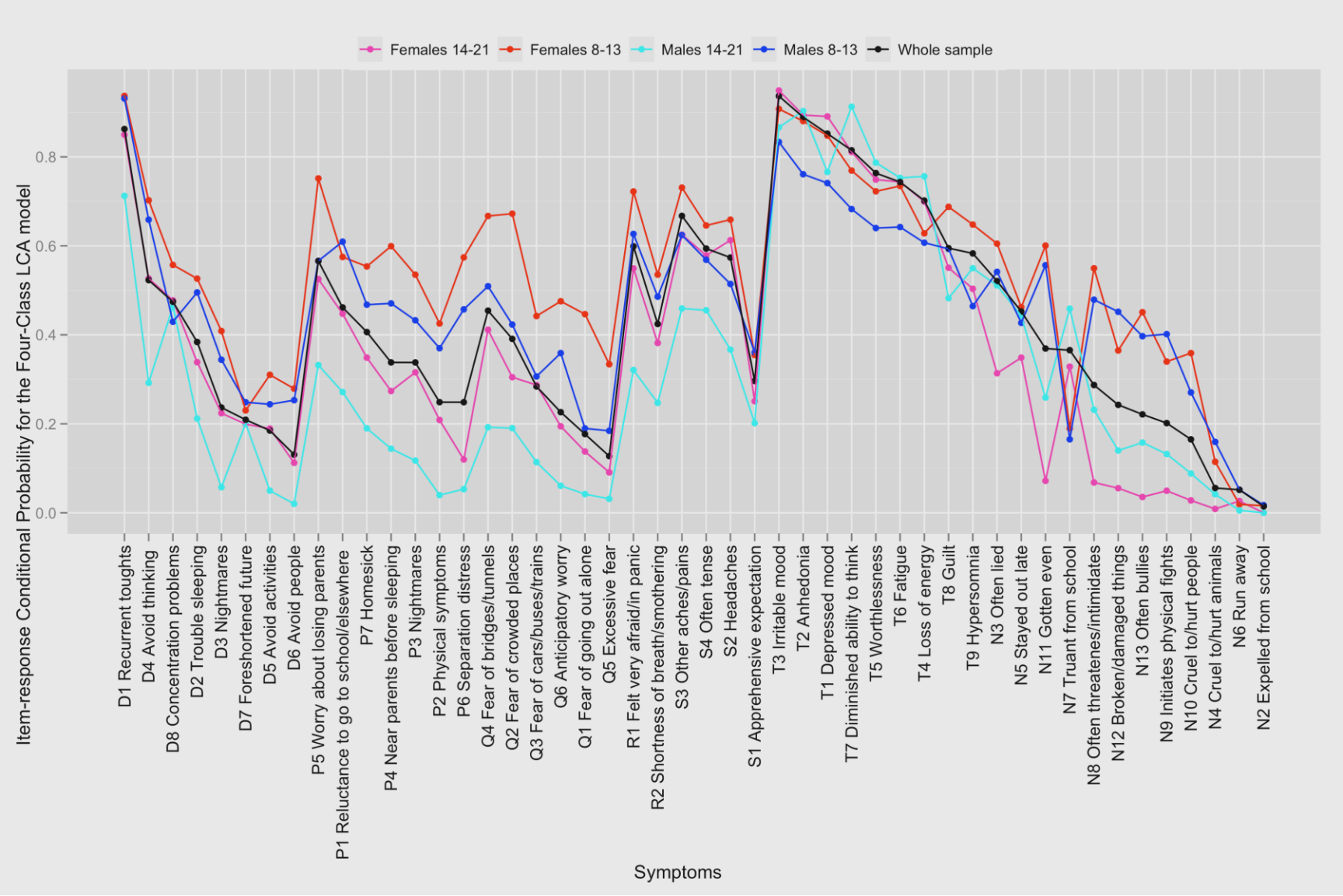

Figure 16. Estimated response probability profiles for the anxious-misery class in the whole sample and in the sample stratified by gender and age groups.

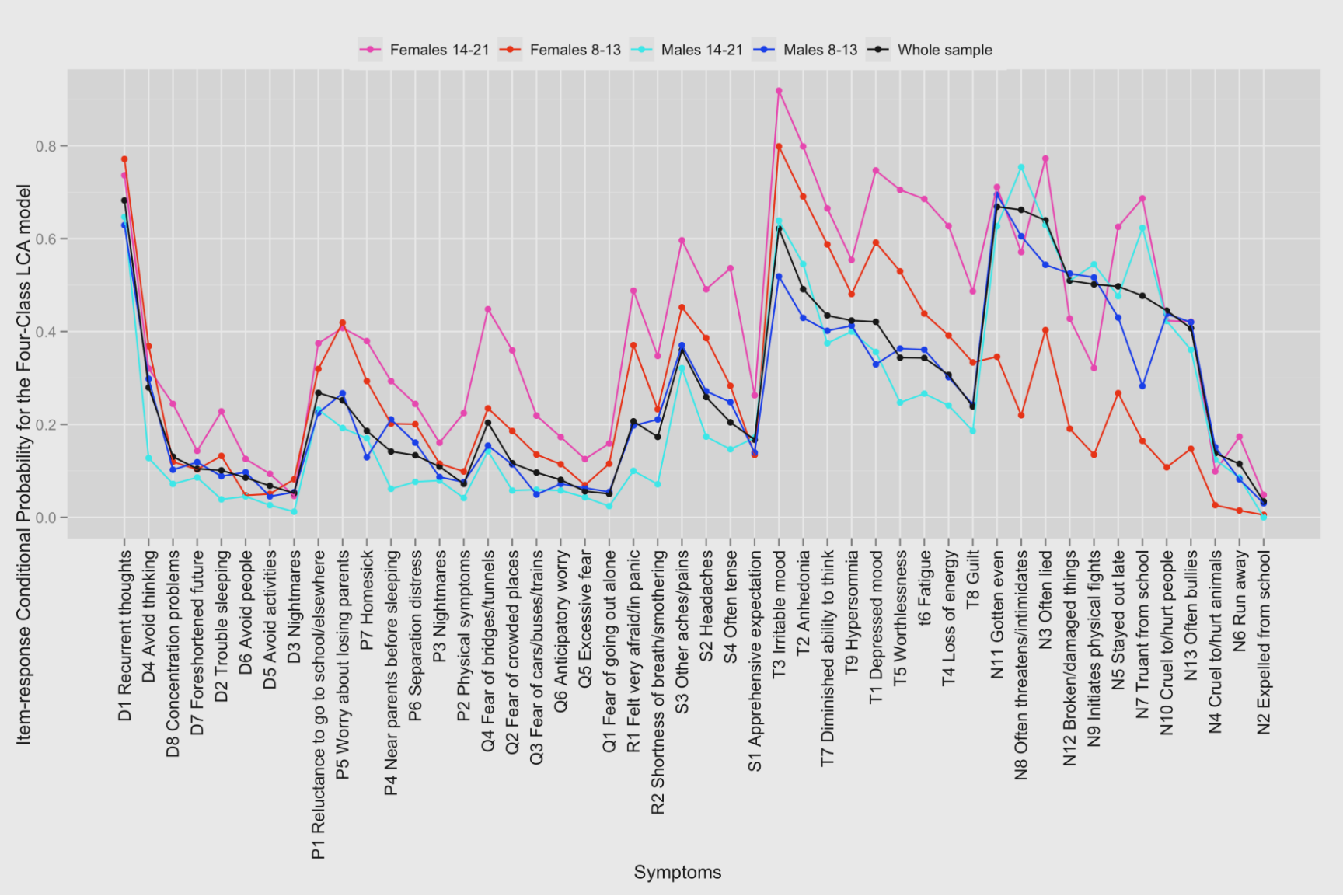

Figure 17. Estimated response probability profiles for the externalizing class in the whole sample and in the sample stratified by gender and age groups.

even), and only in the older boys indicators of serious violations of rules (N7 Truant from school). Girls in the age range between 14-21 years old show a severe externalizing profile as well. It is interesting to note that the CD symptoms that characterize the female version of the externalizing disturbance are slightly different from the male version. In particular, the symptom of deceitfulness (N3 Often lied), rather than aggressive behavior, shows the highest conditional probability along with the symptoms of severe violations of the rules (N5 Stayed out late and N7 Truant from school), and, similar to males profiles, the symptom of ODD (N11 Gotten even). The widest gaps are displayed for symptoms of CD between young and older boys, older girls and young girls in the age range between 8-13 years old.

4.7 Dimensional scaling and differential item functioning of PTSD symptoms

4.7.1 Factor analysis and unidimensionality

An initial MCA was performed on the DPS PTSD and PTSD-RI symptoms respectively. The goal of this analysis was to identify clusters of symptoms to define the factor structure to subsequently test with confirmatory factor analysis of different mode solutions. The screeplot of the eigenvalues suggested retaining the first 2 axes of variation. Figure 18 plots the top two dimensions of the MCA performed on the DPS PTSD symptoms. The first dimension represents the largest amount of inertia (32.51%). It was hypothesized that the first axis reflects the variation of psychopathology between a condition of no distress and the manifestation of DPS PTSD symptoms. The second dimension (12,62% of inertia) separated symptoms of avoidance (D6 Avoid people, D5 Avoid activities/places, D4 Avoid thinking) and numbing (D7 Foreshortened future) from symptoms related to sleep problems (D3 Nightmares and D2 Insomnia) and the symptoms of arousal (D8 Concentration problems) and re-experiencing (D1 Recurrent thoughts). The plot also shows that children in grade 4^{th} and 5^{th} were more likely to report the endorsement of symptoms of avoidance.

Similar to the DPS PTSD symptoms analysis, in the PTSD-RI symptoms MCA the screeplot of the eigenvalues suggested retaining the first 2 axes of variation. Figure 19 plots the top two dimensions, which explain the 33,30% and 10,35% of the total inertia. The first dimension represents the largest deviation from independence by opposing those who reported PTSD-RI symptoms vs. those who did not. The second dimension separated symptoms of numbing (E9 detachment or estrangement from others) and arousal (E6 difficulty concentrating; E3 irritability) and sleep related symptoms (E5 difficulty falling or staying asleep; E8 nightmares) from symptoms of avoidance and re-experiencing (E7 avoidance of activities, places or people associated with the trauma; E4 avoidance of thoughts; E1 psychological distress; E2 recurrent thoughts).

A confirmatory factor analysis was conducted for models with one and two factors for DPS PTSD and PTSD-RI symptoms. The rationale to divide symptoms into the factors to be examined by the CFA relied

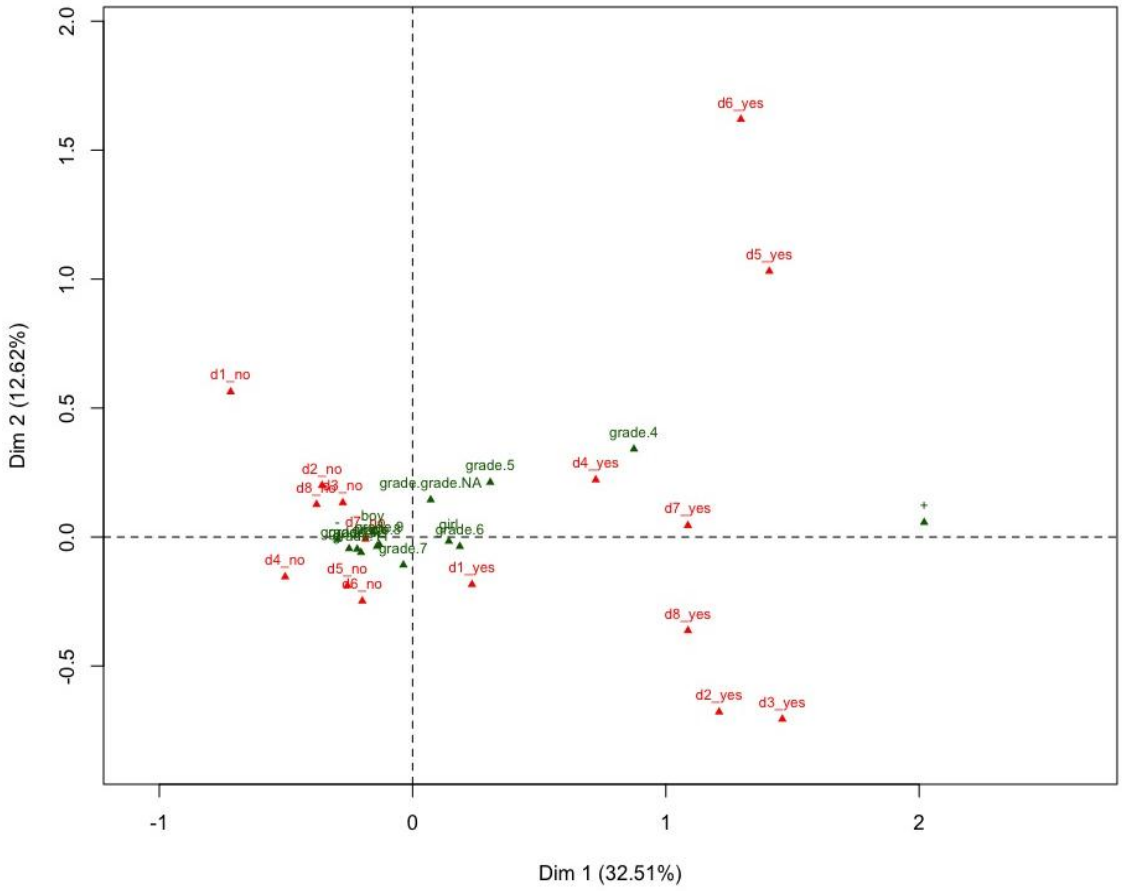

Figure 18. MCA factor map (dimension 1 and 2) of DPS PTSD items.

on the results of the previously mentioned exploratory analysis on DPS PTSD and PTSD-RI symptoms respectively. In particular, the clustering of the symptoms identified by the second dimension of the DPS PTSD MCA provides the rationale for the identification of two main factors: avoidance and sleep related symptoms. The clustering of the symptoms identified by the second dimension of the PTSD-RI MCA provides the rationale for the identification of two main factors: 1) numbing, arousal, and sleep related symptoms, and 2) symptoms of avoidance and re-experiencing. Both sets of CFA revealed that the solution with one factor was the one that best fitted the data (Figure 20). The one factor solution of DPS PTSD symptoms (RMSEA = 0.067, CFI = 0.910, and Goodness-Of-Fit index = 0.976) was performed on 8 items. The most representative items of the factor identified for the DPS scale were “D2 Difficulty falling/staying asleep” and “D8 Difficulty concentrating”, with the top factor loadings of 0.25 and 0.24 respectively.

The one factor solution of PTSD-RI symptoms (RMSEA = 0.048, CFI = 0.952, and Goodness-Of-Fit index = 0.985) was performed on 9 items. The five levels of the Likert scale answers to the items were

recoded into binary variables in which “none”, “little” and “some” were recoded as 0 and “much” and “most” as 1. The most representative items of the factor identified for the PTSD-RI scale were “E2 I have upsetting thoughts or pictures of what happened come into my mind when I do not want them” and “E1 I get upset, afraid or sad when something makes me think about what happened”, with the top factor loadings of 0.19 and 0.18 respectively.

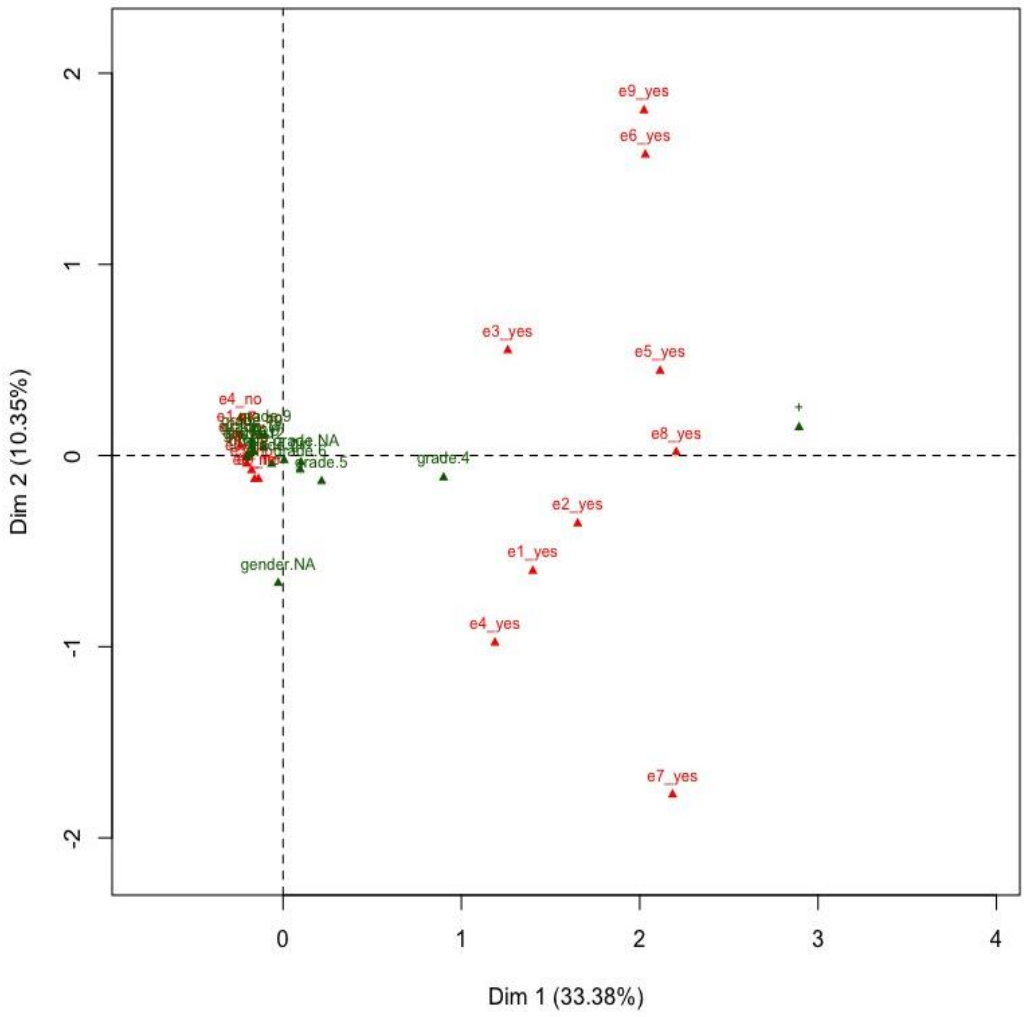

Figure 19. MCA factor map (dimension 1 and 2) of PTSD-RI items.

4.7.2 IRT model parameters and item characteristic curves (ICC) for DPS PTSD

The IRT model parameters and associated item characteristic curves (ICCs) for each DPS PTSD item are shown in Table 17 and Figure 21, respectively. The magnitude of the discrimination estimates (*a* parameter) determined the extent to which each criterion was able to discriminate the individuals along the underlying PTSD continuum. In other words, item discrimination parameters indicate the strength of the relation of the individual items to the latent PTSD trait. These values are analogous to item loadings

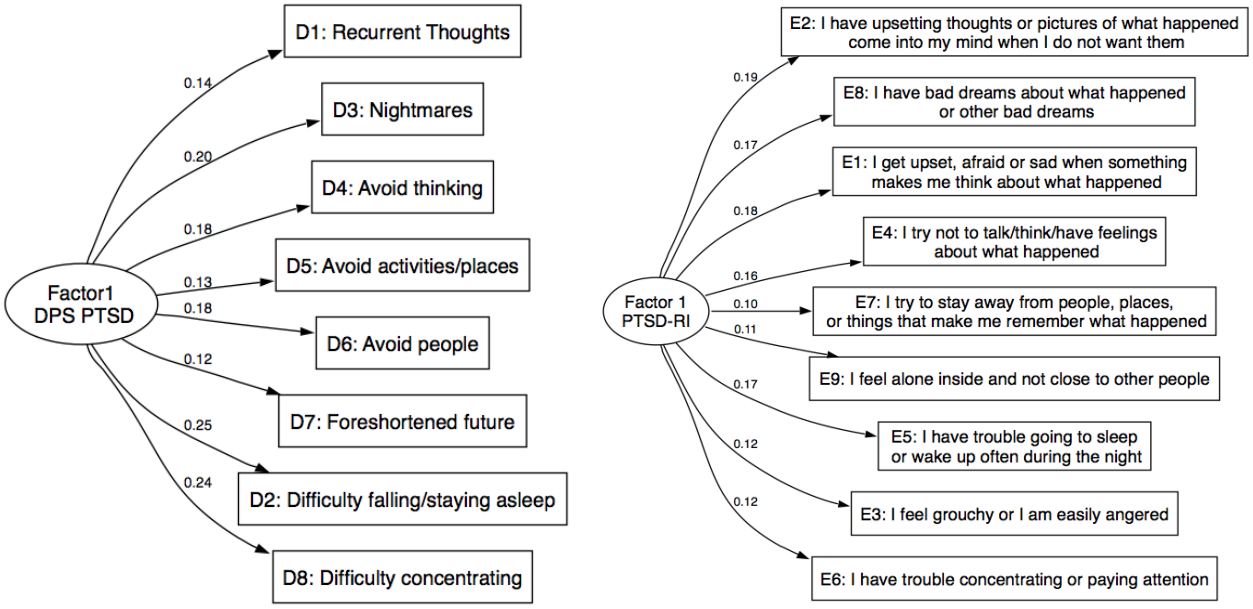

Figure 20. One factor solution model from CFA with DPS PTSD items (left) and PTSD-RI items (right).

from a factor analysis. Item discrimination parameters for PTSD criteria were all greater than 1. Discrimination was greatest for sleep related problems: problems falling or staying asleep (D2) and nightmares (D3), whereas discrimination for foreshortened future (D7) and recurrent thoughts of what happened or was seen during on 9/11 (D1) were among the lowest.

The item severity parameters (*b*) for the PTSD criteria indicate the level of the latent trait at which the criterion is most informative. For example, $b_i = 1$ suggests that criterion *i* is most useful for distinguishing between patients who are close to 1 SD above the mean on the latent PTSD trait. Item severity parameters for the PTSD criteria range from −1.26 (D1) to 1.99 (D7). The −1.26 item severity parameter for item 1 (recurrent thought) means that this particular item is commonly endorsed even by those subjects who have lower than average PTSD levels (i.e., 1.26 SDs below the mean of the latent PTSD trait). With respect to the severity parameter, cluster C (avoidance and numbing) criteria demonstrated the greatest severity: avoidance of places and activities (D5), avoidance of people (D7) and sense of foreshortened future (D7).

Table 17. IRT Parameters for DPS PTSD

Items	Discrimination Parameter (S.E.)	Severity Parameter (S.E.)
D1. Often thought about what happened or was seen	1.09 (0.04)	-1.26 (0.05)
D2. Problems falling or staying asleep	1.99 (0.07)	0.99 (0.03)
D3. A lot of nightmares	2.04 (0.08)	1.31 (0.03)
D4. Tried very hard not to think, hear, or talk about it	1.44 (0.05)	0.35 (0.02)
D5. Stopped going places or doing things that remind you of it	1.68 (0.07)	1.46 (0.04)
D6. Tried to keep away from people who remind you of it	1.30 (0.06)	1.85 (0.06)
D7. Stopped thinking about the future	1.07 (0.05)	1.99 (0.08)
D8. Harder to concentrate	1.74 (0.06)	0.91 (0.03)

Figure 22 shows the test information curve (TIC) for this set of PTSD criteria. Test information curves indicate where the severity of disorder can be most accurately scaled across the range of the latent trait. The severity parameters for the DPS PTSD criteria are probably below the range one would expect for a clinical measure. Only four of the eight PTSD criteria were most informative above 1 SDs from the mean (3, 5, 6, and 7); the TIC reflects this, showing that the PTSD criteria provide the best information for the dimensional scaling of individuals with moderate severity of PTSD. In other words, the DPS PTSD criteria assess the moderate severity range of the continuum better than the higher or more severe end of the continuum. The standard error of measurement (SEM) curve shows that the magnitude of error across levels of severity of the PTSD continuum is lowest at the moderate severity range of the continuum; the SEM curve shows more error in measurement at the lower and higher levels of severity of the PTSD continuum.

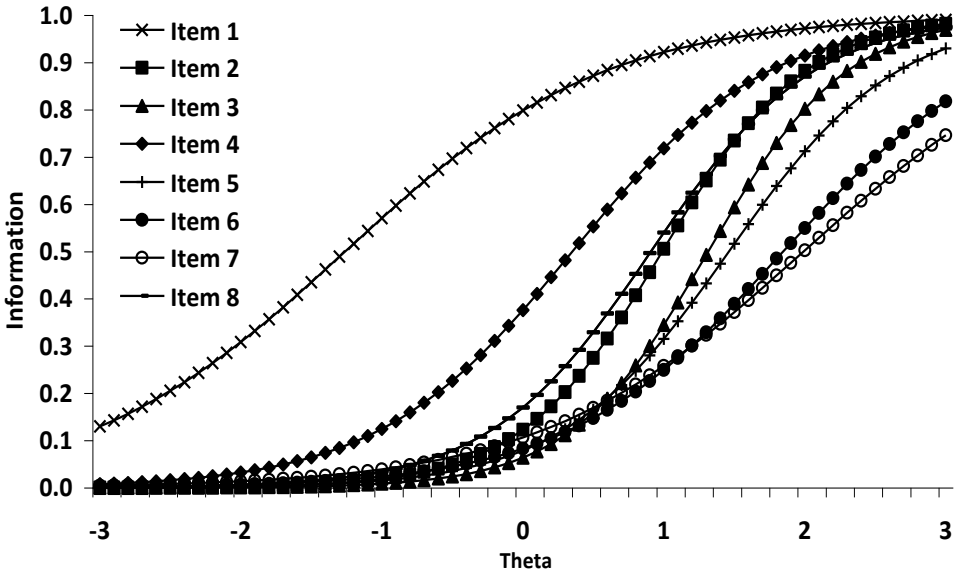

Figure 21. Item characteristic curves (ICCs) for DPS PTSD items. On the x-axis, the severity of PTSD is scaled to have a mean of 0 and an SD of 1. The severity parameter for an item can be determined by identifying the point on the x-axis where the probability of endorsement (y-axis) is 50%. For example, the severity parameter for item 7 (foreshortned future) is 1.99. The ICCs also depict the discrimination parameters of items; ICCs with steeper slopes have higher discrimination parameters.

4.7.3 IRT model parameters and item characteristic curves (ICC) for PTSD-RI PTSD

The IRT model parameters and associated ICCs for each PTSD-RI PTSD were calculated with different ways of scoring the PTSD-RI items. First, 0 (none) answers were considered negative, and 1 – 4 (little – most) answers were considered positive (Figure 23). Second, 0 (none) and 1 (little) answers were considered negative, and 2 – 4 (some – most) answers were considered positive (Figure 23). Finally, 0 – 2 (none – some) answers were considered negative, 3 (much) and 4 (most) answers were considered positive. Figure 24 shows ICCs and TIC for each PTSD-RI item recoded this way; the IRT model

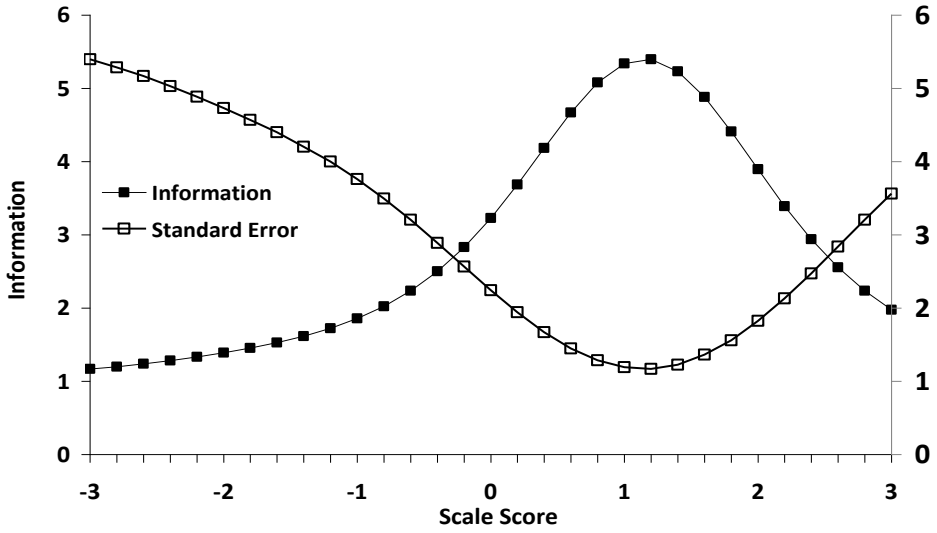

Figure 22. Test information curve (TIC) for PTSD, which displays how all PTSD criteria function together to provide information across the range of severity of the latent PTSD trait. x-axis = the latent PTSD trait expressed as *z scores*. Information: left axis = total information aggregated across all PTSD criteria for each level of severity of the latent PTSD trait. Standard error line: right axis = SE of estimation for each level of severity of the latent PTSD trait.

parameters are shown in Table 18, respectively. The TICs of these three different ways of scoring the PTSD-RI are compared in Figure 25; as it can be seen, when 0 – 2 answers are considered negative and 3/4 answers are considered positive, the TIC reflects this, showing that the PTSD criteria provide the best information for the dimensional scaling of individuals at the more severe end of the continuum. Therefore, this way of scoring the PTSD-RI was selected for the rest of the analyses.

Table 18. IRT Parameters for PTSD-RI (0/1/2 - 3/4)*

Items	Discrimination Parameter (S.E.)	Severity Parameter (S.E.)
E1. Get upset, afraid, or sad when think about it	2.07 (0.10)	1.33 (0.04)
E2. Get upsetting thoughts/pictures of 9/11 when don't what them	2.34 (0.11)	1.37 (0.04)
E3. Feel grouchy or easily angered	1.45 (0.08)	1.70 (0.06)
E4. Try not to talk, think, or have feelings about 9/11	1.54 (0.07)	1.38 (0.05)
E5. Trouble going to sleep or wake up often	2.73 (0.14)	1.51 (0.04)
E6. Trouble concentrating or paying attention	2.09 (0.12)	1.78 (0.05)
E7. Try to stay away from people/places/things that remind me of 9/11	1.90 (0.12)	2.07 (0.08)
E8. Have bad dreams about 9/11 or other bad dreams	3.01 (0.16)	1.54 (0.03)
E9. Feel alone inside and not close to others	1.93 (0.11)	1.90 (0.06)

* Subjects with imputed values were excluded

4.7.4 IRT model parameters and item characteristic curves (ICC) across gender and age

For the four subsamples defined by gender and age (8-13; 14-21), the IRT model parameters for the eight DPS PTSD items and for the nine PTSD-RI items are shown in Table 19. The associated ICCs for DPS PTSD items and for PTSD-RI items are shown in Figure 26 and Figure 27, respectively. The

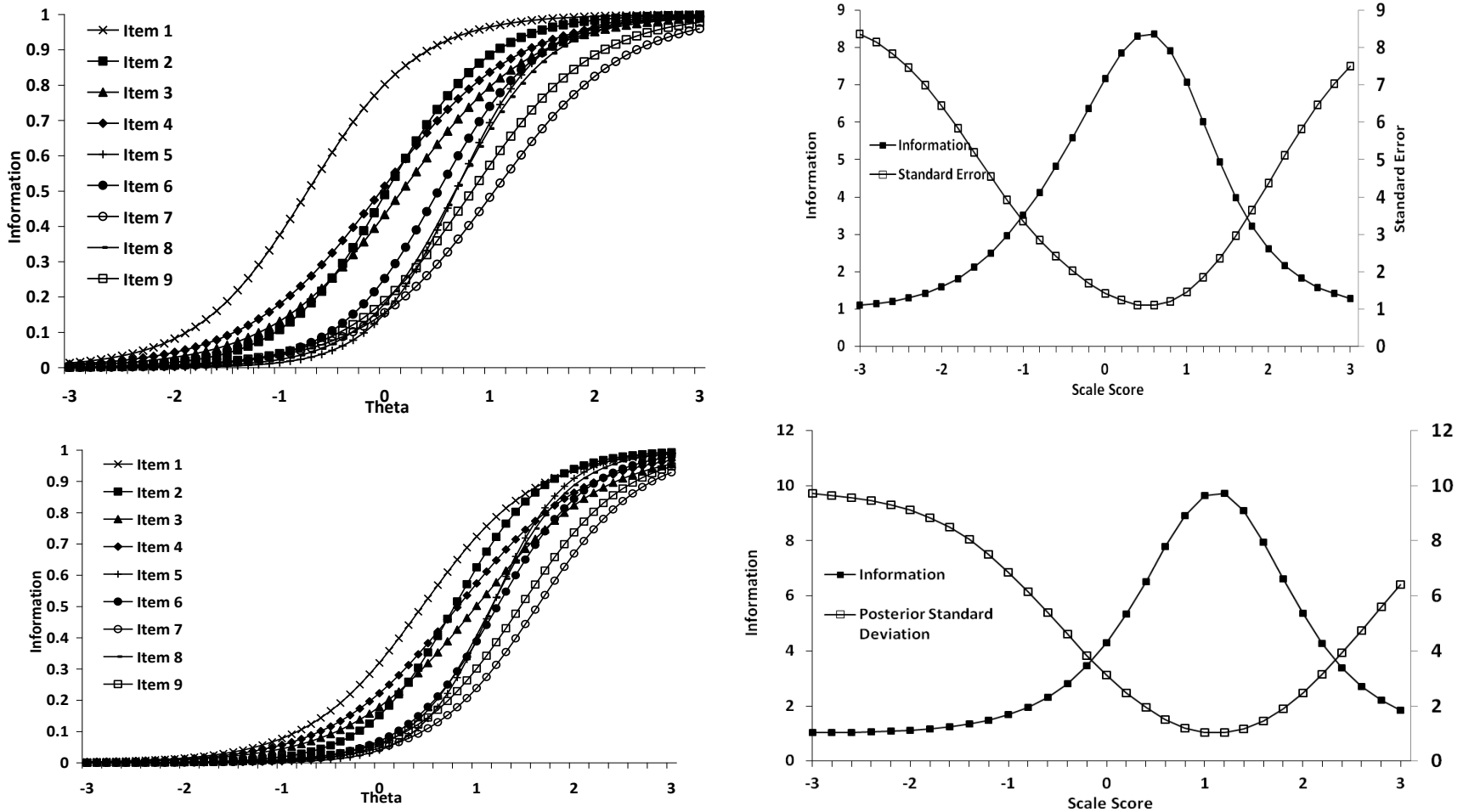

Figure 23. ICCs and TICs for different ways of scoring the PTSD-RI. a) 0 – 1/2/3/4: ICC (top left) and TIC (top right); b) 0/1 – 2/3/4: ICC (bottom left) and TIC (bottom right)

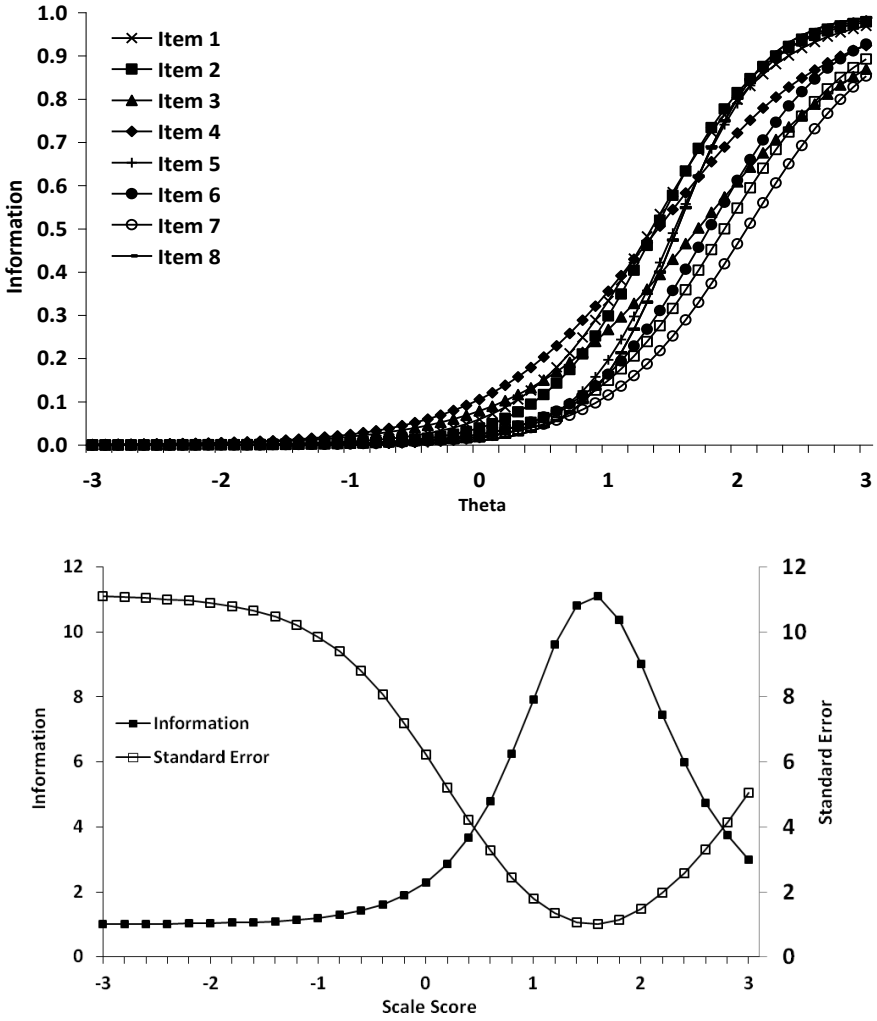

Figure 24. ICC (top) and TIC (bottom) for PTSD-RI (0/1/2 - 3/4)

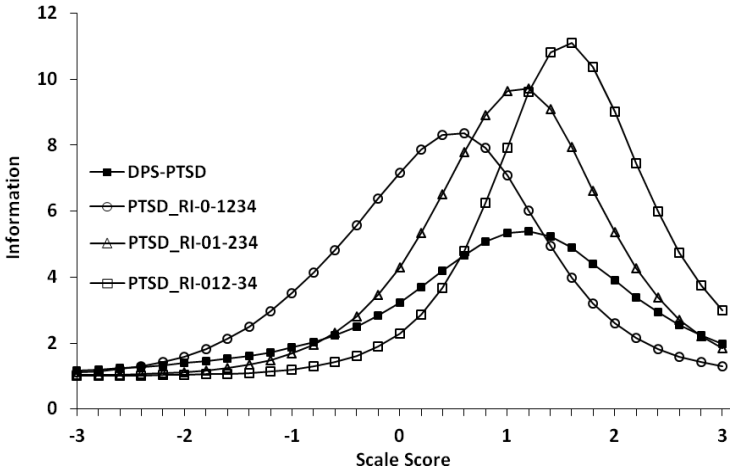

Figure 25. Combined TICs for DPS-PTSD and PTSD-RI

Table 19. IRT model parameters for DPS PTSD items and PTSD-RI items

	Boys 14-21		Girls 14-21		Boys 8-13		Girls 8-13	
DPS	***a***	**S.E.**	***a***	**S.E.**	***a***	**S.E.**	***a***	**S.E.**
D1. Recurrent thoughts	0.519	0.052	0.595	0.057	0.584	0.06	0.753	0.066
D2. Trouble sleeping	1.083	0.107	0.956	0.085	1.193	0.105	1.252	0.093
D3. Nightmares	1.034	0.113	0.992	0.091	1.328	0.124	1.131	0.081
D4. Avoid thinking	0.803	0.07	0.73	0.061	0.891	0.071	0.733	0.052
D5. Avoid activities	1.002	0.105	0.953	0.091	0.862	0.075	0.927	0.067
D6. Avoid people	0.896	0.099	0.588	0.073	0.72	0.068	0.692	0.056
D7. Foreshortened future	0.687	0.067	0.696	0.063	0.593	0.058	0.575	0.053
D8. Concentration problems	1.048	0.097	0.948	0.077	1.06	0.084	1.254	0.088
	b	**S.E.**	***a***	**S.E.**	***a***	**S.E.**	***a***	**S.E.**
D1. Recurrent thoughts	-0.935	0.094	-1.339	0.109	-1.405	0.123	-1.571	0.103
D2. Insomnia	1.496	0.084	1.104	0.067	0.952	0.056	0.625	0.041
D3. Nightmares	2.164	0.139	1.519	0.088	1.184	0.062	0.895	0.049
D4. Avoid thinking	1.069	0.073	0.386	0.05	0.284	0.046	-0.23	0.047
D5. Avoid activities	1.99	0.126	1.527	0.093	1.49	0.094	1.142	0.064
D6. Avoid people	2.272	0.162	2.575	0.254	1.638	0.119	1.486	0.097
D7. Foreshortened future	2.119	0.156	1.982	0.138	1.87	0.151	1.908	0.144
D8. Concentration problems	1.101	0.065	0.92	0.058	0.932	0.057	0.665	0.041
PTSD-RI	***a***	**S.E.**	***a***	**S.E.**	***a***	**S.E.**	***a***	**S.E.**
E1. Psychological distress	1.189	0.122	0.808	0.07	1.276	0.111	0.947	0.068
E2. Recurrent thoughts	1.474	0.159	1.095	0.101	1.244	0.107	1.094	0.077
E3. Irritability	0.813	0.084	0.92	0.081	0.634	0.063	0.69	0.058
E4. Avoid thoughts	0.735	0.076	0.765	0.068	0.853	0.074	0.845	0.061
E5. Insomnia	1.328	0.146	1.266	0.129	1.546	0.15	1.525	0.12
E6. Difficulty concentrating	1.303	0.14	1.289	0.125	1.071	0.111	1.137	0.093
E7. Avoid activities	1.098	0.157	0.918	0.103	0.954	0.096	1.198	0.096
E8. Nightmares	1.183	0.147	1.411	0.152	1.707	0.173	1.616	0.132
E9. Detachment	0.96	0.115	0.944	0.1	1.169	0.127	1.053	0.087
	b	**S.E.**	***b***	**S.E.**	***b***	**S.E.**	***b***	**S.E.**
E1. Psychological distress	1.792	0.097	1.566	0.097	1.437	0.07	1.156	0.062
E2. Recurrent thoughts	1.823	0.088	1.78	0.094	1.346	0.068	1.189	0.058
E3. Irritability	2.155	0.152	1.763	0.102	2.12	0.168	1.825	0.119
E4. Avoid thoughts	2.082	0.153	1.654	0.107	1.502	0.094	1.137	0.067
E5. Insomnia	2.199	0.121	1.909	0.098	1.508	0.068	1.338	0.054
E6. Difficulty concentrating	1.984	0.105	1.942	0.096	2.05	0.124	1.787	0.087
E7. Avoid activities	2.806	0.224	2.797	0.21	2.173	0.14	1.77	0.082
E8. Nightmares	2.48	0.164	1.856	0.09	1.534	0.066	1.273	0.052
E9. Detachment	2.53	0.189	2.339	0.155	2.117	0.125	1.856	0.095

discrimination parameters (*a*), the severity parameters (*b*), and their standard errors of measurement in the four subsamples for DPS PTSD items and PTSD-RI items are plotted in Figure 28.

Item discrimination parameters for DPS PTSD criteria were higher in older boys, while older girls had the lowest values. Across groups, *a* parameters were greater for sleep-related problems (D2 and D3) and

concentration problems (D8). Discrimination for foreshortened future (D7) and recurrent thoughts of what happened or was seen during on 9/11 (D1) were the lowest across groups. Across groups, item severity parameters were lowest for recurrent thought (D1). Across groups, symptoms of avoidance and numbing (DSM cluster C) were the most severe: avoidance of places, activities (D5) and people (D7), and sense of foreshortened future (D7).

Item discrimination parameters for PTSD-RI criteria (with 0/1/2 answers considered as negative, and 3/4 answers considered positive) were generally higher that DPS PTSD criteria. Again, item discrimination parameters were higher in older boys and lower in older girls. Across groups, the highest discrimination parameters were observed for sleep-related problems (E5 and E8) and concentration problems (E6). Discrimination for avoidance of thoughts related to the WTC attack (E4) and for irritability or outburst of anger (E3) were the lowest across groups. Unlike previous results with DPS PTSD symptoms, item severity parameters for PTSD-RI items were all higher than 1 in every groups, with several items being higher than 2. Item severity parameters were higher for older boys.

1.1.1 Differential item functioning (DIF)

The significance of DIF for an item in the contrast between two groups represent the significance of the difference in discrimination and severity parameters graphically represented in Figure 28 and shown in Table 19. Results from DIF analysis applied to DPS PTSD criteria are shown in Table 20. The only symptom with no significant DIF across every pairwise comparison was avoidance of activities and places associated with the WTC attack (D5). Three criteria exhibited DIF in every comparison (D6, D7, D8). In three contrasts (older boys vs younger girls; younger boys vs younger girls; older girls vs younger girls), all items except D5 exhibited significant DIF. Overall, DPS PTSD criteria had significantly lower discrimination parameters in older girls, and significantly greater in older boys. Severity parameters were significantly lower in younger girls, and significantly higher in older boys.

Results from DIF analysis applied to PTSD-RI criteria are shown in Table 21. The only symptom with no significant DIF across every pairwise comparison was avoidance of thoughts associated with the WTC attack (D5). Four criteria exhibited DIF in every comparison (E2, E3, E6, E7). Only two criteria (E4, E8) had significant DIF in the comparison between older and younger boys; in all other contrasts, not more than 3 items showed significant DIF. Overall, across the two age groups PTSD-RI criteria had significantly lower discrimination parameters in girls, and significantly greater in boys. Younger girls had significantly lower severity parameters, while older boys had significantly lower severity parameters.

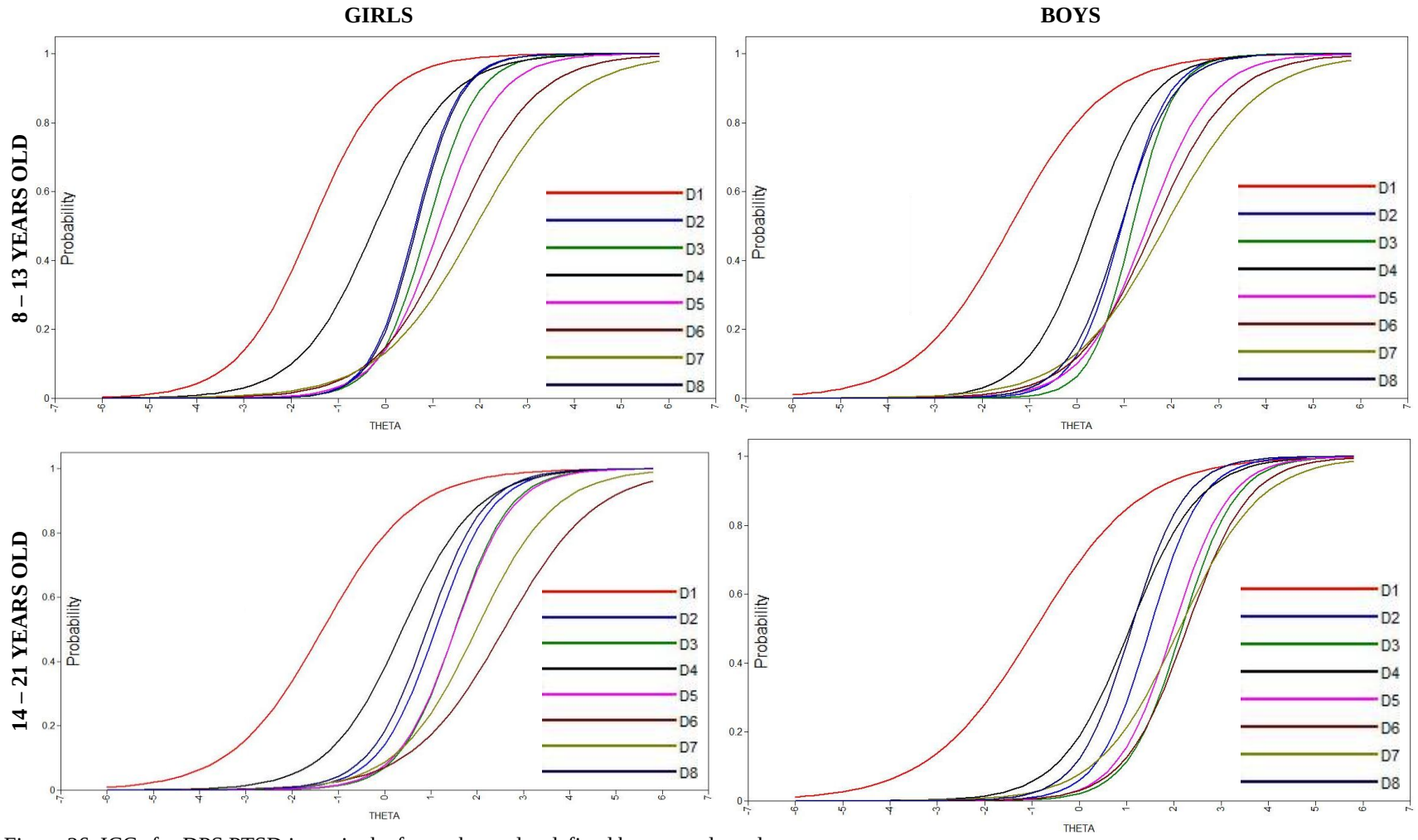

Figure 26. ICCs for DPS PTSD items in the four subsamples defined by age and gender.

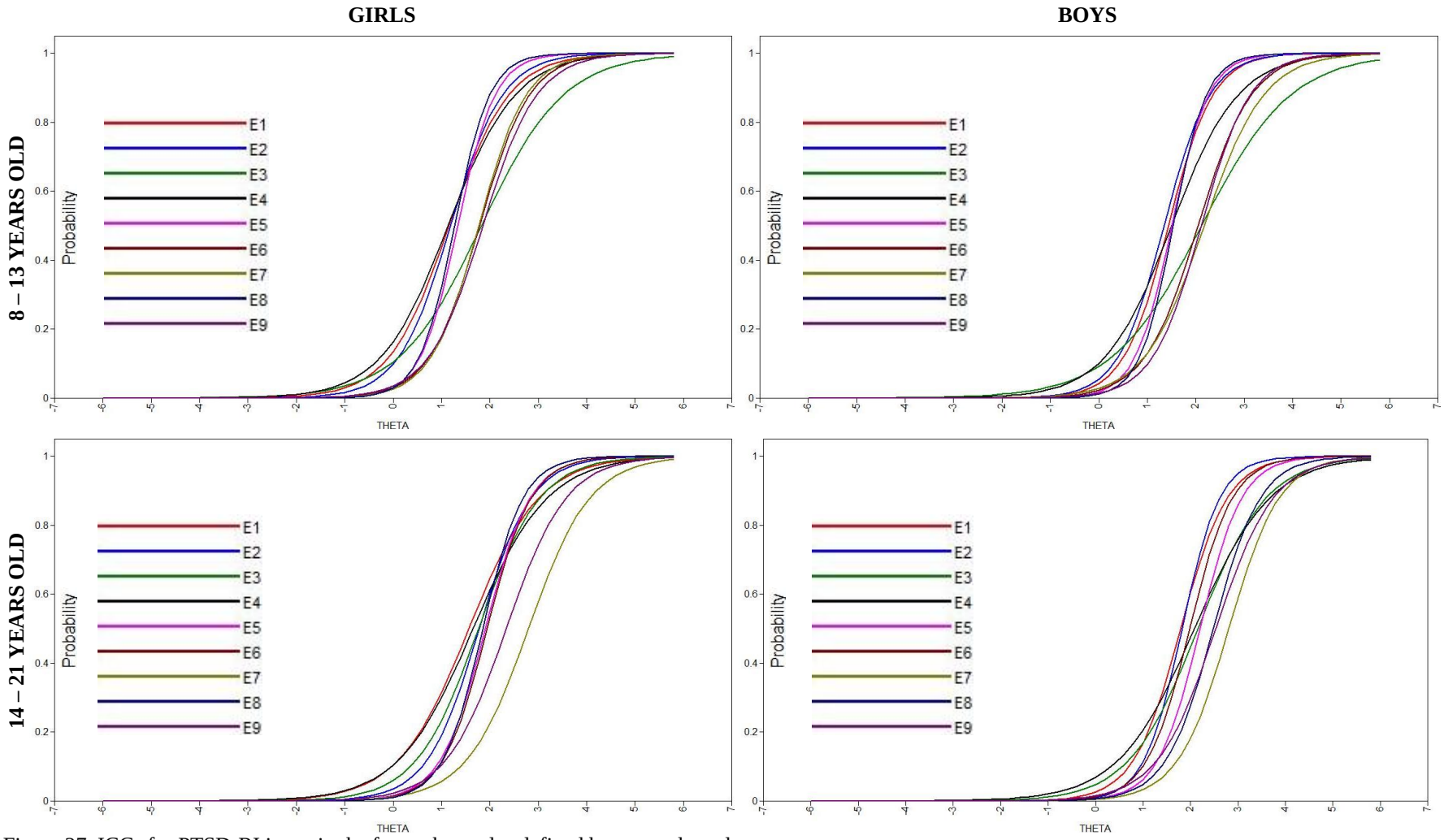

Figure 27. ICCs for PTSD-RI items in the four subsamples defined by age and gender.

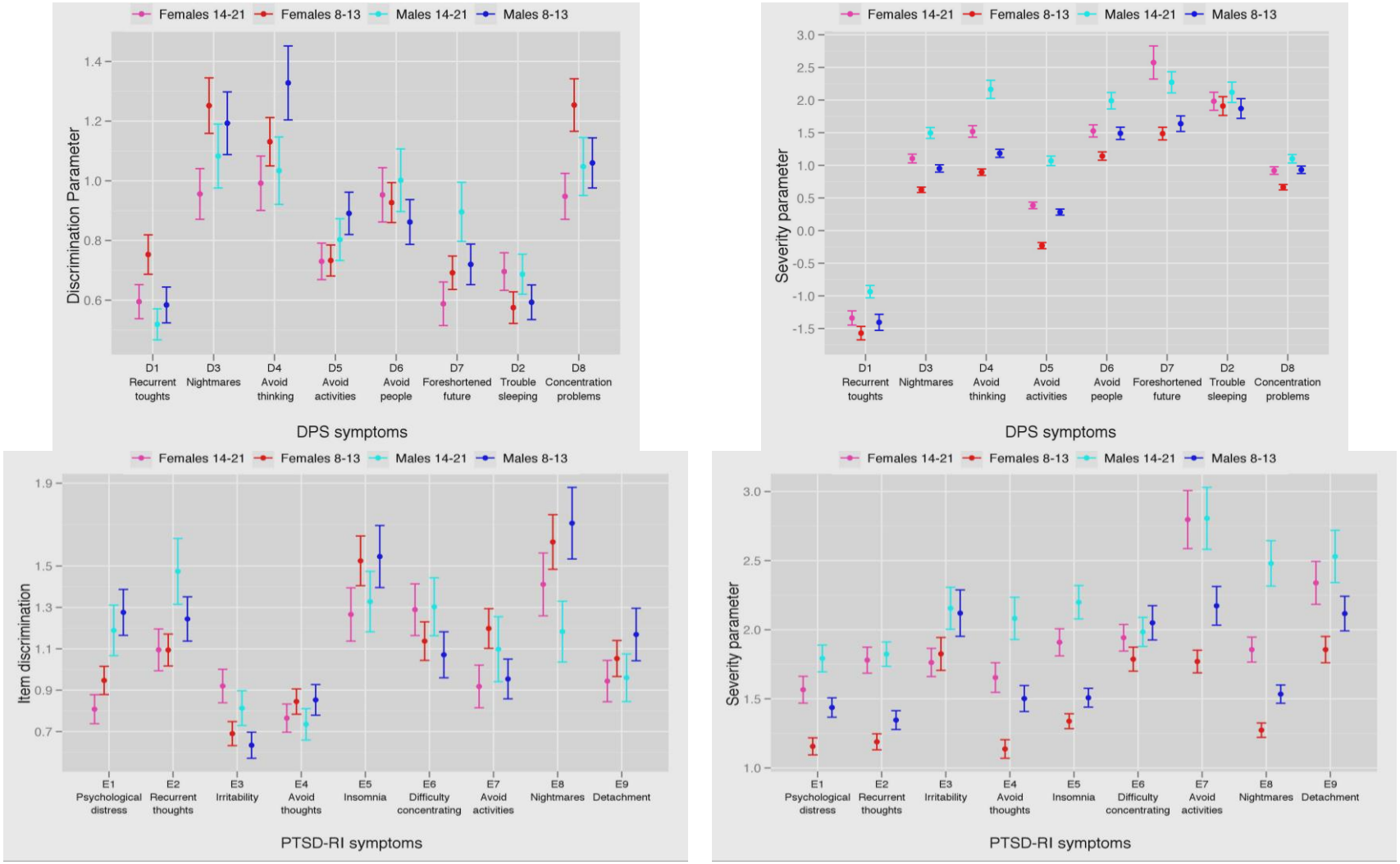

Figure 28. Plot of discrimination parameters (*a*), severity parameters (*b*), and their standard errors of measurement in the four subsamples for DPS PTSD items and PTSD-RI items.

Table 20. Differential item functioning of DPS PTSD symptoms.

	Boys 8-13 vs Boys 14-21		Boys 14-21 vs Girls 14-21		Boys 14-21 vs Girls 8-13		Boys 8-13 vs Girls 14-21		Boys 8-13 vs Girls 8-13		Girls 14-21 vs Girls 8-13	
	Hyp. Test	G^2	**Hyp. Test**	G^2	**Hyp. Test**	G^2	**Hyp. Test**	G^2	**Hyp. Test**	G^2	**Hyp. Test**	G^2
D1. Recurrent thoughts	All equal	1.5	All equal	1.6	All equal	8.6	All equal	1.6	All equal	8.6	All equal	8.2
					a equal	6.4			a equal	6.4	a equal	5.7
					b equal	2.2			b equal	2.2	b equal	2.5
D2. Trouble sleeping	All equal	1.9	All equal	3.3	All equal	4.7	All equal	3.3	All equal	4.7	All equal	4.5
					a equal	3			a equal	3	a equal	2.9
					b equal	1.7			b equal	1.7	b equal	1.6
D3. Nightmares	All equal	1.8	All equal	0.6	All equal	10.2	All equal	0.6	All equal	10.2	All equal	9.7
					a equal	0			a equal	0	a equal	0
					b equal	10.2			b equal	10.2	b equal	9.7
D4. Avoid thinking	All equal	0.8	All equal	0.4	All equal	41.8	All equal	0.4	All equal	41.8	All equal	40.1
					a equal	3.4			a equal	3.4	a equal	3
					b equal	38.4			b equal	38.4	b equal	37.1
D5. Avoid activities	All equal	3.6	All equal	2.5	All equal	0.3	All equal	2.5	All equal	0.3	All equal	0.2
D6. Avoid people	All equal	19.7	All equal	26.3	All equal	5.3	All equal	26.3	All equal	5.3	All equal	5.6
	a equal	0.5	a equal	4	a equal	0.1	a equal	4	a equal	0.1	a equal	0.1
	b equal	19.3	b equal	22.3	b equal	5.2	b equal	22.3	b equal	5.2	b equal	5.5
D7. Foreshortened future	All equal	6	All equal	8.9	All equal	15.6	All equal	8.9	All equal	15.6	All equal	16.3
	a equal	0.5	a equal	6.8	a equal	1.1	a equal	6.8	a equal	1.1	a equal	1
	b equal	5.5	b equal	2.2	b equal	14.5	b equal	2.2	b equal	14.5	b equal	15.3
D8. Concentration problems	All equal	12	All equal	5.8	All equal	71.8	All equal	5.8	All equal	71.8	All equal	70.7
	a equal	0.2	a equal	0.1	a equal	11.7	a equal	0.1	a equal	11.7	a equal	11.7
	b equal	11.7	b equal	5.7	b equal	60	b equal	5.7	b equal	60	b equal	59

Table 21. Differential item functioning of DPS PTSD symptoms.

	Boys 8-13 vs Boys 14-21		Boys 14-21 vs Girls 14-21		Boys 14-21 vs Girls 8-13		Boys 8-13 vs Girls 14-21		Boys 8-13 vs Girls 8-13		Girls 14-21 vs Girls 8-13	
	Hyp. Test	G^2	**Hyp. Test**	G^2	**Hyp. Test**	G^2	**Hyp. Test**	G^2	**Hyp. Test**	G^2	**Hyp. Test**	G^2
E1. Psychological distress	All equal	27.9	All equal	26.8	All equal	0.9	All equal	26.8	All equal	0.9	All equal	0.9
	a equal	7.4	a equal	4.8			a equal	4.8				
	b equal	20.5	b equal	22			b equal	22				
E2. Recurrent thoughts	All equal	8.2	All equal	10.4	All equal	4.1	All equal	10.4	All equal	4.1	All equal	4.1
	a equal	0.3	a equal	0.1	a equal	2.6	a equal	0.1	a equal	2.6	a equal	2.6
	b equal	7.9	b equal	10.3	b equal	1.6	b equal	10.3	b equal	1.6	b equal	1.5
E3. Irritability	All equal	6.4	All equal	15.6	All equal	8.4	All equal	15.6	All equal	8.4	All equal	7.9
	a equal	6.3	a equal	14.8	a equal	1.5	a equal	14.8	a equal	1.5	a equal	1.6
	b equal	0.1	b equal	0.8	b equal	6.9	b equal	0.8	b equal	6.9	b equal	6.3
E4. Avoid thoughts	All equal	1.4	All equal	0.2	All equal	1.4	All equal	0.2	All equal	1.4	All equal	1.5
E5. Insomnia	All equal	5.4	All equal	1.3	All equal	1	All equal	1.3	All equal	1	All equal	1
	a equal	0.1										
	b equal	5.3										
E6. Difficulty concentrating	All equal	4.5	All equal	7.8	All equal	16.3	All equal	7.8	All equal	16.3	All equal	16.5
	a equal	1.7	a equal	6.9	a equal	0	a equal	6.9	a equal	0	a equal	0
	b equal	2.8	b equal	0.9	b equal	16.3	b equal	0.9	b equal	16.3	b equal	16.5
E7. Avoid activities	All equal	14.2	All equal	11.8	All equal	6.6	All equal	11.8	All equal	6.6	All equal	6.8
	a equal	5.2	a equal	0.7	a equal	3.1	a equal	0.7	a equal	3.1	a equal	3
	b equal	9	b equal	11.2	b equal	3.5	b equal	11.2	b equal	3.5	b equal	3.8
E8. Nightmares	All equal	0.9	All equal	0.2	All equal	5.6	All equal	0.2	All equal	5.6	All equal	5.5
					a equal	0.7			a equal	0.7	a equal	0.7
					b equal	4.9			b equal	4.9	b equal	4.8
E9. Detachment	All equal	7.2	All equal	1	All equal	0.8	All equal	1	All equal	0.8	All equal	0.8
	a equal	1										
	b equal	6.2										

5 DISCUSSION

5.1 Exploratory Multiple Correspondence Analysis

Initially, a multiple correspondence analysius (MCA) was used to explore the relationship among the available large set of categorical variables and generate a global picture of the salient relationships among these variables simultaneously. Commonly used exploratory multivariate techniques include principal components analysis (PCA) and factor analysis (FA). These techniques were, however, designed for use with continuous variables and use the Pearson correlation coefficient as the measure of association. MCA is a technique that is designed specifically for the analysis of categorical variables and that is not yet widely used in epidemiological research. This technique preserves the categorical nature of the variables because the analysis is conducted at the level of the response categories themselves rather than at the variable level. The primary goal of MCA is to illustrate the most important relationships among the variables' response categories using a graphical representation. Furthermore, MCA is a versatile technique in part because no underlying distributional assumptions are required.

5.2 Risk factors for PTSD and MDD

As mentioned in the background, many studies have looked at the risk for PTSD in children in relation with broad measure of exposure but few have assessed exposure to a full range of specific events related to a major man-made disaster. Efficient treatment and prevention strategies require knowledge of the conditional risk for PTSD, given different event categories across the full range of potentially vulnerable groups. Information on specific risk factors associated with PTSD is important for the appropriate allocation of mental health resources after disasters. Only data from community samples can provide this information (Copeland et al., 2007b; Fairbank et al., 2000).

The relationship of traumatic events and PTSD involves interactions among multiple factors that can be summarized into three aspects. First, there are pre-traumatic factors that render an individual vulnerable to a disorder. These include genetic susceptibility, demographic characteristics, such as female gender, previous traumatic experiences, premorbid personality traits, preexisting psychiatric and family histories, social resources, personal adjustment, intellectual functioning, and one's style of coping with stressful events. Second, trauma-related factors include the nature of the traumatic event, the initial exposure experience, and early responses. Third, there are post-trauma factors that are highly related to the posttraumatic environment and rescue or relief conditions (Hsu et al., 2002). The balance of personal and environmental resources in the recovery environment plays an important role in determining posttraumatic adjustment. Variables that favor greater chronicity and severity of PTSD symptoms, spreading comorbidities, and greater functional impairments include the use of maladaptive coping

strategies, such as alcohol abuse and rigid avoidance of reminders, new stressful life events in the year after exposure, poorer social supports, and more negative work environments.

5.2.1 Pre-trauma factors

5.2.1.1 Gender

It was found that female gender is a strong predictor of PTSD. The association of female sex with higher scores of PTSD symptoms is usually consistent with the literature (Copeland 2007) (Breslau et al.; Breslau et al.; Breslau et al.; Copeland et al.; Cuffe et al.; Goenjian et al.; Goenjian et al.; Kessler et al.; La Greca et al.; La Greca et al.; Lonigan et al.; Roussos et al.; Shannon et al.; Tolin and Foa). Though this gender difference is fairly clear from an epidemiologic perspective, the mechanisms for this disparity are uncertain; they may involve both differences in types of trauma exposure and differences in response to trauma (Nemeroff et al., 2006). In adults, it has been reported that the increased prevalence of PTSD in women remains even when trauma type is controlled for (Tolin and Foa, 2006). Conceivably, there may be a biological basis to women's apparent increase vulnerability to traumatic reactions (Nemeroff et al.). For example, Barr et al. (2004b) have shown that an orthologous polymorphism (rh5-HTTLPR) of the human serotonin transporter promoter polymorphism (5-HTTLPR) modulates the effect of early adversity on adrenocorticotropic hormone and cortisol response to stress in female, but not male, rhesus macaques. These findings suggest that women with the short allele of the serotonin transporter promoter polymorphism may be more susceptible to the effects of early adversity, an interactive mechanism that might underlie the increased risk among women for certain stress-related syndromes such as PTSD (Barr et al., 2004a; Barr et al., 2004b).

Regarding explanations that focus on differences in type of exposure, studies on adults have shown that subjects with histories of childhood trauma have increased rates of PTSD. Although childhood sexual trauma has been the most intensively studied in the literature on childhood trauma, other types of maltreatment, emotional abuse in particular, may be at least as important in explaining gender differences in PTSD (Nemeroff et al., 2006). Studying 8667 adult members of a health maintenance organization, Edwards et al. (2003) found that while men reported significantly more physical abuse, women reported a significantly higher prevalence of sexual abuse as well as moderate or severe emotional abuse in the family environment during childhood (Edwards et al., 2003). Thus, among youths, differences in types of trauma exposure, possibly relating to sexual and emotional trauma in childhood, may explain some of the gender differences in rates of PTSD (Nemeroff et al., 2006).

5.2.1.2 Age

Among demographic variables, also younger age was strongly associated with PTSD. With regard to age, the literature on children and adolescents reports mixed results. After Hurricane Hugo, Shannon et al.

(1994) found that children younger than 13 were more likely to test positive for posttraumatic stress syndrome than older children. Posttraumatic stress symptoms did not differ by grade among 3rd-5th grade children exposed to Hurricane Andrew (La Greca et al., 1996). Green et al. (1991) did not find any significant difference in the diagnosis of probable PTSD among three age groups (2–7, 8–11, and 12–15 years) after the Buffalo Creek disaster (Green et al., 1991). However, there was a significant difference in the average number of PTSD symptoms, with the youngest age category showing fewer symptoms. In a study among students exposed to the Chi-Chi earthquake in Taiwan (Chen et al., 2002)(Chen et al., 2002), elementary school students experienced more severe PTSD symptoms compared to junior high school students. After the earthquake in Armenia, there was no association found between the severity of PTSD and age among students 8–16 years old (Pynoos et al., 1993). In a representative population sample of children and adolescents from North Carolina, adolescence was associated with an increased risk for posttraumatic stress symptoms in the presence of a traumatic event (Copeland et al., 2007b). Consistent with this finding, in the National Survey of Adolescents, older age was associated with increased risk for PTSD (Kilpatrick et al., 2003). However, correlation coefficients suggested that older adolescents also were more likely than younger adolescents to report familial alcohol and drug use-problems, witnessed violence, sexual assault, and physical assault (Kilpatrick et al., 2003). Similarly, in a high-risk sample of young adults in urban United States, the occurrence of traumatic events up to age 6–7 was less than 1%, and that age-specific occurrence rose markedly after age 15, with the highest rate observed between 16 and 18 years of age (Breslau et al., 2004a; Breslau et al., 2004b). Thus, relations between age and mental health outcomes may be strengthened, in part, through shared variance with other stressful life circumstances not assessed in the study.

5.2.1.3 Race

No significant relationship was found between race and PTSD. The literature on children and adolescents reports mixed results also with regard to age. In the previously mentioned study conducted on 5,687 school-aged children assessed three months after Hurricane Hugo (Shannon et al., 1994), African-American children reported different demographic and hurricane exposure characteristics than did the other children, demographic and exposure factors were statistically equated. After controlling for the effect of reported severity of the hurricane, the degree of home damage, continued displacement, parents' occupation and reported levels of trait anxiety, African-American children reported significantly more symptoms then non-African-American children. Among 3rd-5th grade children exposed to Hurricane Andrew, La Greca et al. (1996) found that children from minority ethnic groups did report more symptoms of posttraumatic stress at each time point, and these effects were observed even after controlling for exposure. According to La Greca et al. (1996), these ethnic differences in PTSD reporting may be related to other variables associated with minority status, such as the limited availability of

financial resources. In the National Survey of Adolescents (Kilpatrick et al., 2003), Hispanic ethnicity and African American race were significantly associated with non-comorbid PTSD in the final multivariable logistic regression. On the contrary, rates of painful recall and subclinical PTSD (endorsing at least 1 symptom each of painful recall, hyperarousal, and avoidance symptoms but not meeting full PTSD criteria) did not differ across ethnic groups in a large study by Copeland et al. (2007). Consistent with the findings of Copeland et al. (2007), race was not significantly related to either exposure to traumatic events or to PTSD in a large sample of young adults (Breslau et al., 2000).

5.2.1.4 Previous trauma exposure

Many respondents have been exposed to potentially traumatic events before 9/11 (Table 2); for example, about 35% of the sample reported having seeing somebody killed or seriously injured. This is consistent with the literature. Epidemiological surveys have documented that most community residents in the United States have experienced traumatic events (Breslau et al., 1998; Breslau et al., 2004a; Breslau et al., 2004b; Kessler et al., 1995). Considerable proportions of those who experienced any traumatic event have experienced more than 1 such event (Breslau et al., 1998; Breslau et al., 2004a; Breslau et al., 2004b; Kessler et al., 1995). However, in disagreement with the literature, exposure before 9/11 to the 6 specific events assessed in the NYC-DES was not associated with the likelihood of being positive for PTSD at the time of the survey. The association of prior exposure to traumatic experiences with the risk for posttraumatic reactions following a new trauma has been often reported in the literature on PTSD (assessed in relation to events different from 9/11) in children, adolescents and young adults (Bremner et al., 1993; Breslau et al., 1999; Kulka et al., 1990; Zaidi and Foy, 1994; King et al., 1996; Galea et al., 2002; Goenjian et al., 1994; Goenjian et al., 2008) (Copeland et al, 2007).

Thus, several studies have shown that previous traumatic experiences seem to moderate risk for developing PTSD in response to a new trauma (Heim and Nemeroff, 2009). There is a rich literature documenting that early adverse experience, including prenatal stress and stress throughout childhood, has profound and long-lasting effects on the development of neurobiological systems, thereby programming subsequent stress reactivity and vulnerability to develop PTSD (Meaney and Szyf, 2005; Nemeroff et al., 2006; Seckl and Meaney, 2006). For example, non-human primates exposed to a variable foraging demand condition, which causes unpredictable maternal care infants, produce an adult phenotype with sensitization to fear cues, corticotropin-releasing factor (CRF) neuronal hyperactivity, and hypocortisolism similar to features of PTSD (Coplan et al., 1996). In another non-human primate study, maternal separation interacted with female gender and the 5-HTTLPR polymorphism of the serotonin transporter gene in determining adult sensitization to acute stress (Barr et al., 2004a). Adult women with childhood trauma histories exhibit sensitization of neuroendocrine and autonomic stress responses (Heim et al., 2000). There have been attempts to link the identified neurobiological changes observed in PTSD to

the specific features that constitute PTSD, such as altered mechanisms of learning and extinction, sensitization to stress, and arousal (Heim and Nemeroff, 2009). Core features of PTSD include enhanced negative feedback control of the HPA axis that occurs in the context of increased autonomic responsiveness as well as increased central nervous system (CNS) CRF and noradrenergic activity (Heim and Nemeroff, 2009). The specific constellation of neuroendocrine findings in PTSD reflects sensitization of the HPA axis to exposure to stressors (Heim and Nemeroff, 2009; Yehuda, 2006). Furthermore, increased cerebrospinal fluid (CSF) concentrations of CRF have been measured in patients with PTSD (Baker et al., 1999; Bremner et al., 1997). CSF CRF concentrations are believed to reflect CRF activity at extra-hypothalamic sites. In view of the CNS effects of CRF, as described in various animal models, increased CNS CRF activity may promote certain of the cardinal features of PTSD, such as conditioned fear responses, increased startle reactivity, hyperarousal and sensitization to exposure to stressors. In sum, neurotransmitter changes observed in PTSD patients likely reflect sensitization of stress-mediating systems and/or decreased ability to restrain stress responses in order to regain homeostasis (Heim and Nemeroff, 2009). Several studies have reported elevated rates of prior traumatic events in adults with PTSD (Bremner et al., 1993; Breslau et al., 1999; Kulka et al., 1990; Zaidi and Foy, 1994; King et al., 1996; Galea et al., 2002). The finding has been interpreted as supporting a sensitization process, that is, greater responsiveness to subsequent stressors (Post and Weiss, 1998; Post et al., 1997).

The discrepancies between results from the NYC-DES and the findings summarized above have some plausible explanations. The evidence supporting the influence of prior trauma on the PTSD effects of a subsequent trauma comes primarily from cross-sectional studies in which retrospective data on earlier events are obtained from trauma-exposed persons with and without PTSD (Breslau et al., 2008). Retrospective accounts of traumatic events are subject to recall bias, a limitation that threatens the validity of causal inferences. Persons with psychiatric disturbances might be more likely to recall negative experiences, whereas those with no psychiatric disturbance might be more likely to forget and less likely to attribute causal meaning to objectively similar events (Brewin et al., 1993; Kessler, 1997; Schraedley et al., 2002). A reporting bias associated with psychiatric status is likely to influence reports of prior trauma and lead to an apparent (but spurious) association between PTSD and prior trauma. The limitations of retrospective data are well recognized and are acknowledged in studies that seek to identify causal pathways based on cross-sectional data (Breslau et al., 2008).

In addition, a generally overlooked major limitation of studies on the effects of prior trauma (affecting also the NYC-DES) is their failure to assess how persons had responded to the prior trauma, specifically, whether or not they had developed PTSD in response to the prior trauma. Consequently, it is unclear whether prior trauma alone or prior PTSD amplifies the risk of PTSD after a subsequent trauma (Breslau et al., 2008). Evidence that previously exposed persons are at increased risk of PTSD only if their prior

trauma resulted in PTSD would not support the hypothesis that exposure to traumatic events increases the risk of (i.e., sensitizes them to) the PTSD effects of a subsequent trauma, transforming persons with normal reactions to stressors into persons susceptible to PTSD. It might suggest the possibility that trauma precipitates PTSD in persons with preexisting susceptibility (that had already been present before the prior trauma occurred). A predisposition to a pathological response to stressors might account for the PTSD response to the prior trauma as well as to the subsequent trauma. Evidence that personal vulnerabilities, such as neuroticism, a history of major depression and anxiety disorders, and family history of psychiatric disorders, increase the risk of PTSD has been consistently reported (Casella and Motta, 1990; Hyer et al., 1994; Talbert et al., 1993; Breslau et al., 1991, 2006; Koenen et al., 2007; Storr et al., 2007; Brewin et al., 2000; McFarlane, 1989). There also is evidence that personal vulnerabilities are stronger predictors of a psychiatric response to traumatic events than is trauma severity, especially in civilian samples (McFarlane, 1988, 1989).

In a longitudinal epidemiological study of young adults with repeated assessments during a 10-year follow-up period, Breslau et al. (2008) estimated the risk of PTSD associated with stressors experienced during the follow-up periods in relation to the respondents' prior traumatic events and PTSD that had occurred during preceding periods. The study addressed the limitation due to potential recall bias in previous cross-sectional studies. Information on prior trauma (the predictor) collected in earlier assessments is uncontaminated by the respondents' PTSD associated with new exposure during subsequent periods collected in subsequent assessments (the dependent variable). More importantly, the availability of data on the PTSD effects of the prior traumas provided an opportunity to examine the following question: does earlier trauma per se or only earlier trauma that culminated in PTSD predict the PTSD response to a subsequent trauma?

The authors found that prior exposure to trauma increased the risk of the PTSD effects of a subsequent trauma only among persons who had developed PTSD in response to the prior trauma. Those who had experienced a prior trauma but had not developed PTSD in response to the prior trauma were not at elevated risk of PTSD when they experienced a subsequent trauma. These prospective data do not support the suspected sensitization effect of prior trauma. The studies that gave rise to the sensitization hypothesis, including the 2 studies that Breslau and colleagues conducted in samples of the general population (Breslau and Anthony, 2007; Breslau et al., 1999) did not obtain information on the PTSD response to the prior trauma. That information appears to be crucial. Without it, any observed difference in the PTSD risk between trauma-exposed persons with vs those without prior trauma is ambiguous as evidence concerning the role of prior trauma in PTSD. The information about the PTSD response to the prior trauma suggests the possibility that preexisting susceptibility might account for the PTSD response to the prior trauma and the PTSD response to the subsequent trauma.

Although prior trauma alone did not predict the PTSD effects of a subsequent trauma (Breslau et al., 2008), there is no direct evidence to explain how prior PTSD increased the risk of the PTSD response to a subsequent trauma. The possibility that preexisting vulnerabilities (i.e., present before the prior trauma occurred) might account for the finding is supported by the body of evidence that personal susceptibilities have a key role in PTSD. Other factors should be considered. Among them are (1) PTSD cases identified at baseline might already have been sensitized by early childhood traumas, which were undetected by Breslau and collegues (2008), and (2) PTSD from a subsequent trauma among respondents with prior PTSD might have been a continuation of chronic, unremitted PTSD. As to the first factor, although traumatic events that occurred in childhood were not examined prospectively by Breslau et al. (2008), the authors found no evidence that childhood events, when selected by the respondents as the worst (or only) events at baseline, were associated with an elevated PTSD risk. To exclude the first hypothesis the authors also mention a prospective population study that detected a very low conditional risk of PTSD in childhood (Costello et al., 1998). As to the second factor, Breslau et al (2008) found that PTSD from a new trauma, at the first or the second follow-up, could not be explained as the persistence of unremitted prior PTSD. Approximately 75% of cases of lifetime PTSD ascertained at the baseline assessment and the additional cases of PTSD that occurred after trauma experienced during the first follow-up period had remitted at the start of the respective follow-up periods. The risk of the PTSD effects of a subsequent exposure varied little between remitted and active cases.

5.2.2 Trauma-related factors

A wide range of specific types of exposure was studied in association with PTSD six month after 9/11. Even though several events related to direct, indirect and media exposure were associated with PTSD in the first set of multivariate logistic regressions, variables assessing direct exposure to the WTC attack were not significantly associated with PTSD in the final model. As noted by Neria, Galea, and Norris (2009), disaster research (including 9/11-related research) has frequently involved populations that were not directly exposed to the trauma, such as people who experience loss of family members or friends, or those who suffered property loss, were forced to relocate, or were exposed to the event through the media. This raises two critical points about the burden and the nature of post-disaster psychopathology. There is little question that there is a dose-response relationship between the extent of trauma and the mental health burden of disasters; however, this relation may not necessarily mean that the principal population mental health burden of a disaster is among those who were most directly affected by the disaster (Galea et al., 2005; Neria et al., 2008). Family exposure to the WTC attack was associated with PTSD, even more strongly than direct exposure. This suggests that some children may experience greater emotional impact from having a family member exposed than from being directly exposed themselves. This result suggests that post-disaster intervention may need to be broadly focused, including parental/family experience and

loss. Although in some studies in adults, indirect exposure to the WTC attacks was not shown to be associated with risk of PTSD (Neria et al., 2006), findings from large-scale, representative studies in adults (Galea et al., 2002; Schlenger et al., 2002; Silver et al., 2002) provide strong evidence for a probable association between indirect exposure and PTSD. Most of the persons interviewed in post-9/11 national surveys reported an indirect exposure to the attacks, mostly through TV broadcasts (Neria et al., 2008). The inclusion of this type of exposure is certainly new to the discipline of trauma research and deserves further attention (Ahern et al., 2002). After 9/11, at least two national studies on adults have reported an association between extensive viewing of television coverage and substantial stress reactions, although the causal directionalities of this association have not been elucidated (Schlenger et al., 2002; Schuster et al., 2001). The events of 9/11 provide an opportunity to examine whether direct exposure to trauma is a necessary condition for PTSD, or whether alternatively, an interaction between a 'sufficient' level of exposure (even indirect), and certain risk factors (e.g., previous exposure to traumatic events) can result in true post-exposure psychopathology. Specifically, findings from nationwide studies in adult populations have pointed to substantial and enduring emotional reactions across the United States after the 9/11 attacks, suggesting that the effects of this high-impact national trauma were not limited to the communities directly affected and, in fact, were comparable across groups with both direct and indirect exposure to the attacks. These findings may challenge one of the core criteria of PTSD (i.e., Criterion A) according to *DSM–IV–TR* (American Psychiatric Association, 2000). The inclusion of this type of exposure is relatively new to the discipline of PTSD research and deserves further attention. The events of 9/11, other terrorist attacks in Europe and Asia, and recent major natural disasters provide further opportunities to examine whether direct exposure to trauma is a necessary condition for PTSD or whether, alternatively, an interaction between a sufficient level of exposure (even indirect) and certain risk factors (e.g., genetic susceptibility) can result in post-exposure psychopathology (Neria et al., 2011).

Only 18 studies focused on samples of children after human-made disasters (Neria et al., 2008). They studied samples exposed to the: 1984 school playground sniper attack in Los Angeles; 1988 school shooting in Winnetka, Illinois; 1993 World Trade Center bombing; 1995 Oklahoma City bombing; 1998 American Embassy bombing in Nairobi, Kenya; 1998 discotheque fire in Goteborg, Sweden; and the 9/11 terrorist attacks in New York City and Washington, DC. Because the assessment measures that were used in these studies were different, and some studies chose to measure posttraumatic symptoms only, cross-study comparisons of the prevalence of PTSD in children is limited (Neria et al., 2008). Yet, the evidence suggests a particularly high prevalence of PTSD among directly exposed children. For example, the prevalence of PTSD among exposed children was 38.4% at 1 month after the 1984 school playground sniper attack in Los Angeles (Pynoos et al., 1987), 27% at 3 months after the 1993 World Trade Center bombing (Koplewicz et al., 2002), and 18.4% at 6 months after the 9/11 terrorist attacks in New York

City (Hoven et al., 2005). A possible explanation for the lack of association between direct exposure events and PTSD in the final model is that a combination of events (dose of response) is required to develop PTSD in vulnerable individuals. Thus, just the cumulative effects of direct exposure events will produce an observable effect. Furthermore, specific direct exposure events might not exert an independent contribution to PTSD risk; the lack of association between direct exposures and PTSD might be explained by mediating variables. For example, the significant relationship between media exposure and PTSD in the final model might mediate the relationship between direct exposure and PTSD, since children who are directly exposed to 9/11 might be more likely to be subsequently exposed to 9/11 through the media. Finally, it has been found that the extreme intensity of some situations will lead to initial symptoms in virtually everyone, whereas with less extreme exposure, individual vulnerability factors have a more significant influence (Asarnow et al., 1999; Lewin et al., 1998; Nolen-Hoeksema and Morrow, 1991). Since the intensity of peritraumatic reactions and DSM-IV A2 criterion were not assessed, it might be that the majority of kids experienced moderate levels of direct exposure; the effect of those events six months after 9/11 might be overruled by indirect exposure events, media coverage and post-trauma factors (see below).

5.2.2.1 Media

Among trauma-related factors, the effect of media exposure deserves further attention. The WTC attack introduced further complexities in the interpretation of criterion A1 in the diagnosis of PTSD. The burning Twin Towers could be viewed from a distance of miles; media coverage was extensive for days and weeks after afterward. All of these 9/11-related experiences could be considered a form of witnessing. In DSM criterion A1[1], the 'witnessing' specification does not require one to be an eyewitness or even observe the scene from a circumscribed proximity. Numerous studies related to September 11th reported on the prevalence of PTSD among populations of Manhattan and Washington, DC, and surrounding areas, and in national samples as far away as Houston, Tex., and Los Angeles (North et al., 2009). Presumably, most of the people in these locations had not been personally present at the site and did not have a close friend or family member who was injured or killed or directly endangered by the attacks. Thus, they must have been considered PTSD candidates (and many were identified as having PTSD) through viewing television coverage of the attacks, hearing about it, or somehow perceiving that they too were endangered (North et al., 2009b; Silver et al., 2002). The above studies carefully represented the findings not as PTSD but as "stress symptoms", "symptoms of PTSD", and "probable PTSD". Several authors have cautioned that such symptoms do not necessarily imply psychopathology

[1] Criterion A1: the person experienced, witnessed, or was confronted with an event or events that involved actual or threatened death or serious injury, or a threat to the physical integrity of self or others

but may represent normal responses to an event of extreme proportions. The same argument could be made for the current findings.

Nevertheless, the above studies assessed PTSD in adults. In children the effect of media exposure might be stronger; in a sample of children and adolescent from NYC, the effect might be even stronger. Using the same questionnaire developed by Hoven et al. (2005), a recent study on 427 adolescents (mean age = 16.20 years) in NYC did not find an association between media exposure and PTSD. However, it should be noted that in this study even direct and indirect exposure didn't predict youth's PTSD symptoms, in odds with the literature. As pointed out by the authors, the lack of association between 9/11 exposure and mental health symptoms may be a function of the length of time between 9/11 and the interviews (on average 15 months); thus, it is likely that more immediate effects of 9/11 exposure on the youth's mental health might have largely diminished with time (Gershoff et al., 2010).

In a national, representative sample of children aged 2 to 17, media exposure, above and beyond other factors, predicted increased worry following the September 11 terrorist attacks. More signs of stress were apparent among 10- to 13-year-olds. Because of their developmental immaturity, children may be confused about the cause of such events, their own relationship to them, and their own vulnerability to similar situations (Becker-Blease et al., 2008). In a small sample of Lon don school children's (N=76; age 10-11 years) who self-reported posttraumatic stress symptoms in response to viewing the attacks of 9/11 on television, a minority of participants reported moderate-severe symptoms with functional impairment at 2 months (14.5%) and 6 months (9.2%) after viewing the 9/11 events. Importantly, viewing media footage from this geographically remote location led to posttraumatic symptoms in those children who experienced the footage as threatening to themselves (Holmes, 2007). Otto et al. (2007) found that for the youngest children (age 10 or below), onset of full or subsyndromal PTSD symptoms was associated with the amount of television viewing on the day of the 9/11 attacks. A notable feature of media coverage of tragic events such as 9/11 is that degree of exposure is not fixed at a single time point. The days and weeks following the initial viewing brought additional coverage. Otto et al. (2007) found that a potential marker of subsequent PTSD symptoms was the degree to which children changed their television viewing habits over the weeks following 9/11. The authors observed a U-shaped relationship, indicating that both avoidance and seeking out additional coverage (as compared to no changes in viewing habits) were associated with PTSD symptoms (Otto et al., 2007).

Print media exposure to the 1995 Oklahoma City bombing was more strongly associated with enduring posttraumatic stress than broadcast exposure (Pfefferbaum et al.; Pfefferbaum et al.). The intentional effort associated with print exposure may reflect the child's level of interest and absorption of the content. Those with more intense reactions to the incident may have actively sought print coverage. There may be differences in processing of broadcast and print material and in memory of information obtained through

different modalities. Reading rather than watching or hearing information may be associated with better retention of information, at least in some. While televised scenes of disaster capture terror and are commonly rebroadcast, these scenes are often fleeting. Printed images may be more compelling than televised images in that they spotlight the most salient and graphic part of an experience. Printed portrayals also endure, allowing one to look at the most dramatic and gripping scenes repeatedly over time and for any length of time. It is not uncommon for television or radio coverage to play as background while children engage in other activities. In these instances, the child's attention to coverage would likely be diminished and passive. Broadcast coverage of the bombing was so extensive that children may have discounted it or "tuned it out." It is also possible that excessive exposure to repetitive images is desensitizing. In the study of Pfefferbaum et al. (2003), the questions pertaining to broadcast media combined television and radio coverage. Both are popular with children, but there may be important differences in the children who choose one form over the other and in the impact of one form or the other. The two forms may be processed differently and may have different impact. Certainly, combining television and radio coverage may have muted the effects of one or the other. Audiovisual processing (associated with television exposure) might be more powerful than auditory processing alone (associated with radio exposure). Furthermore, it is unclear how pervasive bomb-related coverage was on radio stations popular with children (Pfefferbaum et al., 2003).

It should be noted that the relationship between symptomathology and reaction to media coverage may be bidirectional. Those with greater media exposure and stronger reactions to it are more likely to be symptomatic; those who are more symptomatic may have stronger reactions to media exposure and may be drawn to the media coverage to obtain information or maintain a heightened state of arousal.

5.2.3 Post-trauma factors

In this group are included aspects of the post-disaster recovery environment that may either magnify or attenuate children's subsequent reactions. Pynoos and colleagues have considered children and adolescents' reactions to trauma within a developmental life-trajectory model (Pynoos et al., 1995). A child's short-term reaction to a trauma is considered to be moderated by four groups of factors: (1) proximal trauma reminders (e.g., external and internal cues, physiological reactivity); (2) proximal secondary stresses (e.g., changes to family and community circumstances); (3) the "ecology" of the child (e.g., parental, school, and peer factors); and (4) factors intrinsic to the child (e.g., genetic predisposition, developmental competencies). Importantly, it is argued that "the etiology of posttraumatic *distress*, [is derived from] the nature of the *traumatic experience(s)* and from the subsequent *traumatic reminders* and *secondary stressors*" ((Pynoos et al., 1995), p. 72; the italics are the original authors). Thus, a child's long-term reaction and adjustment is likely to be related to ongoing reminders of the trauma and persistent secondary stressors. Post-trauma factors such as exposure to traumatic events after 9/11, restricted travel,

family job loss, the experience of racism, and friends' behaviors were all significant independent risk factors for PTSD in the final model. This is consistent with the literature. Also in adult samples, ongoing stress, including stresses related to the various sequelae of the 9/11 attacks on the WTC, are likely to have played a crucial role in the course of PTSD symptomatology across time in various highly exposed groups (Neria et al., 2011). These findings are consistent also with findings from other studies, which focused on PTSD in children and adolescents in relation to traumatic events different from the WTC attack. Results from these studies are summarized below.

La Greca et al. (1996) examined symptoms of posttraumatic stress in 3rd-5th grade children during the school year after Hurricane Andrew. Post-trauma factors analyzed in their study included, for example, the functioning of significant others in children's lives, the provision of disaster-related interventions, and children's access to supportive relationships. La Greca et al. (1996) included an additional aspect of the post-disaster recovery environment: intervening stressful life events. Major life events that arise after a disaster likely influence and magnify children's stress reactions, although these events are not necessarily related to the disaster itself (La Greca et al., 1996). The role of intervening life events has rarely been addressed in children (La Greca et al., 1996). Thus, La Greca et al. (1996) examined symptoms of PTSD in children with respect to (a) their exposure to traumatic events during and after the disaster, (b) their preexisting demographic characteristics, (c) the occurrence of major life stressors, (d) the availability of social support, and (e) the type of coping strategies used to cope with disaster-related distress. The utility of this conceptual model for understanding children's post-disaster reactions was demonstrated by Vernberg et al. (1996). Specifically, 62% of the variance in children's posttraumatic stress symptoms was accounted for by the primary factors in this conceptual model of the effects of traumatic events, and each factor improved overall prediction of PTSD symptoms when entered in the order specified by the model. La Greca et al (1996) found that major life events (e.g., death of family member, parental divorce) occurring in the months following the hurricane made significant contributions to children's continued post-disaster distress. Life events also predicted increments in children's posttraumatic stress symptoms over the school year. La Greca et al (1996) argue that major life stressors may have an additive effect and magnify children's post-disaster reactions, perhaps by further increasing ongoing daily hassles and strains. Furthermore, major life stressors may serve to limit the social support available to child disaster victims. It was clear from the findings of La Greca et al. (1996) that support from significant others was important for understanding children's post-disaster reactions. Although major life events in the months following the hurricane contributed to PTSD symptomatology, in contrast, the availability of social support appeared to diminish the impact of this disaster over time. With regard to post-disaster adversities, La Greca et al. (1996) reported that major life events' (e.g., death or hospitalization of a family member) made significant contributions to children's continued post-disaster distress.

Goenjian et al., (2005) evaluated the natural course of posttraumatic stress and depressive reactions among untreated adolescents from two cities in an earthquake zone (Gumri and Spitak) and one at the periphery (Yerevan) that were differentially exposed to the 1988 Spitak earthquake in Armenia. PTSD symptoms in Spitak, the city at the earthquake's epicenter, were above the cutoff score for PTSD at 1.5 and 5 years. These high levels of PTSD symptoms are likely attributable to the multiplicity and severity of disaster-related traumatic experiences during and for days after the earthquake. The persistence of PTSD symptoms may be related to the unremitting severe post-earthquake stresses and adversities in the recovery environment, such as impoverished living conditions and a lack of food, heat, and electricity. Furthermore, the persistence of PTSD symptoms may have been related to the high levels of comorbid depression that interfered with the resolution of PTSD symptoms (Goenjian et al., 1995). Finally, the persistence of symptoms may have been related to the pervasive trauma reminders. Up to the 5-year follow-up, throughout Gumri and Spitak, there were numerous destroyed buildings, makeshift homes, debris, and people on the streets with earthquake-related disabilities (Goenjian et al., 2005).

In a school-based study of 1,937 students conducted in two differentially exposed cities (Ano Liosia, at the epicenter, and Dafni) 3 months after the 1999 earthquake in Ano Liosia, Greece, median PTSD levels were higher in Ano Liosia, as would be predicted in a dose of exposure model; however, mean PTSD levels between the two municipalities were not different (Roussos et al., 2005). This finding may reflect the small difference in severity of exposure to the trauma. Adolescents in Dafni may have experienced more PTSD symptoms than expected because of vicarious traumatization. For weeks after the earthquake, the media provided repeated graphic coverage of the event. Such coverage may have constituted repeated traumatic reminders that rekindled symptoms or interfered with their resolution (Nader et al., 1993). A similar lack of difference in PTSD severity between high- and low-exposure groups was noted by among elementary school students after Hurricane Andrew (Shaw et al., 1995). Furthermore, post-earthquake difficulties at home (including conflicts between family members; difficulties with living arrangements; and difficulties with heat, water, or electricity) were more frequently reported in Ano Liosia and were congruent with the more destructive impact of the earthquake in that city. Disaster-related adversities have been reported to interfere with recovery from posttraumatic stress reactions and to be associated with comorbid depression (Goenjian et al., 1988; Carr et al., 1997). The significant difference in mean PTSD and depression scores between those with and without post-earthquake difficulties at home suggests that a comprehensive post-disaster mental health program for children and their families should include assistance in building problem-solving skills and enhancing coping strategies with regard to secondary adversities.

Few studies have focused on the natural course of PTSD and its determinants in samples of the general population (Perkonigg et al., 2005). Risk factors for lifetime chronic (duration at least 1 year) PTSD have

been reported for a random sample of young adults in the Detroit metropolitan area by Breslau and Davis (1992). Compared to young adults with nonchronic PTSD, those with chronic PTSD had a higher number of DSM-III-R PTSD symptoms and higher rates of interpersonal numbing and overreactivity to stimuli that symbolized the stressor, as well as higher rates of psychiatric comorbidity and other medical conditions. Importantly, a recent review on delayed-onset PTSD in adults, showed that in nearly a quarter of the studies (6/27) reporting events or circumstances that could have elicited the onset, the triggers described were reminders of the original trauma (Andrews et al., 2007). Perkonigg et al. (2005) examined determinants of remission and chronicity of PTSD in a prospective community sample of 2,548 adolescents and young adults (age 14–24 years) in Germany. The course of PTSD from baseline to follow-up 34–50 months later was studied in 125 respondents with DSM-IV PTSD or subthreshold PTSD at baseline. Although 52% of the PTSD cases remitted during the follow-up period, 48% showed no significant remission of PTSD symptoms. The experience of new traumatic events between baseline and follow-up was the most robust and significant difference between respondents with a chronic course and respondents with remission. To avoid confounding between the other predictors and new traumatic events, the authors performed a multiple logistic regression analyses using data from the subsample of respondents who had not experienced new traumatic events. Respondents with a chronic course were more likely to have higher rates of avoidant symptoms at baseline (cluster C), and to report more help seeking, compared to respondents with remission. Rates of incident somatoform disorder and other anxiety disorders were also significantly associated with a chronic course. Thus, the experience of new traumas during the follow-up interval distinguished a chronic course from a more favorable course with remission. In addition, a higher number of avoidant symptoms (from cluster C) at baseline predicted a chronic course.

The study by Perkonigg et al. (2005) poses important questions about the mechanisms that can explain why the experience of new traumatic events is associated with a chronic course and why in some individuals initial symptoms are not followed by normal recovery but remain vulnerable to reactivation and even exacerbation. Perkonigg et al. (2005) conclude that "These mechanisms will probably include some brought into play by external triggers, along with some purely internal mechanisms, such as suppression and inhibition, and the interaction of these two types of mechanisms".

In sum, from these studies on young populations, traumatic reminders, persistent secondary stressors and adversities and the experience of new traumas in the recovery environment seem to play a key role in the maintenance of PTSD (Breslau and Davis, 1992; Goenjian et al., 1995; La Greca et al., 1996a; Perkonigg et al., 2005). In addition, these studies pose important questions about the mechanisms that can explain why post-trauma events are associated with a chronic course and why in some individuals initial symptoms are not followed by normal recovery but remain vulnerable to reactivation and even

exacerbation. Monroe and Mineka (2008) argue that it seems plausible that current memory could serve as an influential nodal point in the cognitive and biological system of PTSD and via this mechanism could serve as a contributing factor or driving element in the immediate and ongoing clinical picture of PTSD. Monroe and Mineka (p. 1094) raised a fundamental question: "How can current memory be the cause of PTSD? How could current memory have caused the PTSD of yesterday or yesteryear?" The possible role of memory in the maintenance of PTSD is outlined below (Monroe and Mineka, 2008).

Post-trauma events and memory have a key role in two models of PTSD in adults that have had a tremendous impact on the understanding of the disorder in recent years. These models may also be useful in attempting to understand PTSD in children and adolescents (Meiser-Stedman, 2002) and can help explain why the experience of new traumatic events is a strong predictor of chronic course.

The dual representation theory (Brewin, 2001; Brewin et al., 1996) suggests that trauma stimuli receiving insufficient processing to form ordinary autobiographical memories are stored in a separate image-based "situationally accessible memory" (SAM) system where, in the context of trauma reminders, they give rise to intrusive images and physiological responses until their activation is blocked or inhibited by the creation of corresponding "verbally accessible memory" (VAM) representations. The intrusive images produced by the SAM system consist of re-perceived, sensory representations, whereas intrusive images produced by the VAM system, like those of emotional processing theory, are based on propositional knowledge. The two memory systems continue to operate in parallel. VAMs are theorized to consist of representations of a person's conscious experience of a traumatic event, such as the perceived meaning of the event. Brewin (2001) has presented evidence from a cognitive neuroscience perspective that suggests "traumatic memories" are laid down in a way that bypasses the hippocampus, the neural structure considered to be responsible for the encoding of memories within a temporal and spatial context. As a result of this difference in information processing, "the sensory (visual, auditory, olfactory, etc.), physiological, and motor aspects of the traumatic experience are represented in situationally accessible knowledge in the form of analogical codes that enable the original experience to be recreated" (Brewin et al., 1996, pp. 676–677). Such representations are re-experienced as the result of elicitation through associative learning; trauma-related cues will be likely to trigger such re-experiencing. SAM memories can be difficult to control because people cannot always regulate their exposure to sights, sounds, or smells that act as reminders of the trauma. The emotions that accompany SAM memories are restricted to "primary emotions" that were experienced during the trauma. These memories might explain the cardinal cluster of symptoms observed in individuals with PTSD: the re-experiencing phenomena. Re-living experiences or flashbacks to the trauma are thought to reflect the operation of the SAM system, so called to reflect the fact that flashbacks are only ever triggered involuntarily by situational reminders of the trauma (encountered either in the external environment or in the internal environment of a person's mental

processes). Re-living of these memories is reflected in a distortion in the sense of time such that the traumatic events seem to be happening in the present rather than (as in the case of ordinary memories) belonging to the past. Re-living episodes also do not seem to occur as a result of a deliberate search of memory, but are triggered involuntarily by specific reminders that relate in some way to the circumstances of the trauma, such as the sound of a police siren or the smell of smoke, or particular thoughts or images relating to the event (Brewin and Holmes, 2003). Unlike most other contemporary explanations of PTSD, dual representation theory maintains that the original trauma memories are not altered in any way but remain intact and may be vividly re-experienced again in the future if the person unexpectedly comes across very detailed and specific reminders of the trauma. The presence of unremitting PTSD is termed "chronic emotional processing," and is thought to be associated with inability to integrate memories of the trauma. This may be the result of aversive secondary emotions, as described above, the lack of social support to assist processing of SAMs orVAMs, and ongoing trauma, among other causes. In addition to the symptoms of PTSD, an individual caught in this stage will continue to have attentional and memory biases toward trauma-related information, and develop more generalized secondary reactions.

The second of this new generation of models of PTSD is the one of Ehlers and Clark (2000) (Ehlers and Clark, 2000). The authors based their model on a dual representation format very similar to that of Brewin et al. (1996), but elaborate on both the pathological role of "trauma memory" (their term for Brewin et al.'s "SAMs"), and the cognitions, metacognitions, and thought control strategies considered responsible for the maintenance of PTSD. In Ehlers and Clark's cognitive theory, there is an autobiographical memory system consisting of higher order themes and personal time periods as well as more specific event-related information. Poor incorporation of the event into the more general part of the autobiographical database is thought to result in a memory that is hard to retrieve intentionally, that is experienced as being without a context, and that is easily triggered by physically similar cues. There is also an associative memory system that can process information preconsciously, prime the individual to respond to trauma reminders, and initiate re-experiencing directly in response to relevant cues. In addition to the presence of poorly elaborated trauma memories (the recall of which is easily triggered by associated cues), Ehlers and Clark proposed as central to PTSD appraisals or cognitive interpretations of the world and/or the self that promote a current sense of threat that is accompanied by intrusive phenomena, hyperarousal, anxiety, and other emotional responses. This current sense of threat can either be a perceived external threat to safety or a perceived internal threat to the self and and/or the future. Ehlers and colleagues have demonstrated the maintaining effect of a sense of "current threat" in victims of physical and sexual assault (Dunmore et al., 1999), political prisoners (Ehlers et al., 2000), and motor vehicle accident survivors (Ehlers et al., 1998; Steil and Ehlers, 2000). Cognitions and metacognitions that are thought to give rise to the sense of

"current threat include dysfunctional meaning attached to symptoms of the trauma (e.g., believing that having flashbacks is a sign that one is "going mad"); perceived negative responses from others (e.g., "people think I am too weak to cope on my own"); a sense of permanent change (e.g., "my life is ruined"); and change in global beliefs (e.g., "the world is a dangerous place"). Several prospective studies that followed individuals from very shortly after a trauma to up to a year later have indeed found that these appraisals at about 3 months are important predictors of PTSD severity 6–12 months later (Ehlers et al., 1998; Halligan et al., 2003) In addition, dysfunctional meaning attached to traumatic symptoms was found to be associated with maladaptive coping strategies such as avoidance, thought suppression (an active effort to rid one's mind of a cognition), rumination, and distraction Steil and Ehlers (2000). These strategies are considered to discourage the full processing of traumatic memories, and in the case of thought suppression, paradoxically encourage the production of distressing intrusive cognitions (see Purdon, 1999, for a review). Thus, cognitions and metacognitions that are formed after a traumatic event may promote the maintenance of PTSD in two ways. First, dysfunctional cognitions and metacognitions produce a sense that the trauma continues to have damaging implications, and consequently generate a feeling of apprehension. Second, the thought control strategies that result from these appraisals can discourage emotional processing of memories of the traumatic event.

The role of post-trauma events and memory can also be explained at a biological level. Schwarz and Perry (1994) emphasized the neurobiological impact of a traumatic event, noting that the neurobiological changes thought to result from traumatic stress "create an adaptive record of survival-related information" ((Schwarz and Perry, 1994), p. 312). Such memories are hypothesized to possess a neural network architecture and incorporate information derived from the traumatic event that has a potential bearing on the individual's survival. The activation of these memories by trauma-related cues results in the individual experiencing high levels of noxious arousal, and potentially, cognitive distortions, memory changes, dissociative states, and altered behavioral and affective activity. It is further noted from animal studies that the developing brain is particularly sensitive to stress, especially when such stress is unpredictable and uncontrollable. The authors described how younger children exposed to trauma may experience a more pervasive and persistent increase in basal autonomic tone and develop a posttraumatic reaction where symptoms are elicited by more general stimuli that are unrelated to the trauma. Furthermore, as previously stated, there is substantial evidence for disturbances in several areas of psychobiological functioning in PTSD (Brewin, 2008; Charney, 2004; Dalgleish, 2004). Some biological theories posit that trauma and stress result in dysregulation of the body's core stress-response systems (i.e., the sympathetic–adrenal–medullary system and the hypothalamic–pituitary–adrenal axis; Seckl and Meaney, 2006; Meaney and Szyf, 2005; Nemeroff, 2004; Yehuda, 2006; Heim and Nemeroff, 2009). These adaptive regulatory systems can be sensitized by exposure to traumatic events such that even non-

severe stressors of daily life acquire the ability to trigger excessive neurobiological responses and lead to symptoms and psychopathology (Monroe and Mineka, 2008). In line with current research and theory, neurobiological sensitization to current stressors seems very likely to be instrumental in causing or perpetuating the pathology of PTSD (Monroe and Mineka, 2008).

Finally, there are good reasons to consider that the underlying disorder of PTSD influences memory at least as much as, if not more than, the memory influences PTSD (Monroe and Mineka, 2008). PTSD tends to be associated with a bias toward enhanced recall of trauma-related material (Buckley, Blanchard, & Neill, 2000). "Personal memory is prone to error and distortion, often in systematic ways" (Rubin et al., 2008, p. 997). With respect to past trauma reports, current levels of PTSD symptoms might cause the original event to be remembered as more severe (Rubin et al., 2008). Monroe and Mineka (2008) argue that the disorder of PTSD accounts for the errors and distortions in memory and that it might do so in systematic ways. Also according to Rubin et al., 2008 "What can be concluded is merely the existence of a positive association between PTSD and trauma severity in memory, with the possibility that this relation is caused by the current state of distress as well as by the past objectively viewed reality of the traumatic event" (p. 1001). Several of the studies reviewed by Rubin et al. (2008) evaluated the changes in recall and self-report of traumatic events. The conclusions of these studies were that memory is confounded by current distress and symptoms. Current distress causes problems with recall and/or interpretation of past trauma. For instance, Roemer, Litz, Orsillo, Ehlich, and Friedman (1998) concluded, "Severity of posttraumatic symptomatology was uniquely associated with this change, indicating a possible systematic bias in which severity of symptoms leads to increased reports of stressor frequency" (p. 597). In other words, these researchers directly indicated that the memory of the event may become more threatening as a function of worsening symptoms (see also Caspi et al., 2005; Southwick, Morgan, Nicolau, & Charney, 1997). According to Monroe and Mineka (2008), memory possibly influences the waxing and waning of PTSD over time; changes in memory functioning might contribute to the maintenance of PTSD. It seems plausible that current memory could serve as an influential nodal point in the cognitive system of PTSD and via this mechanism could serve as a contributing factor or driving element in the immediate and ongoing clinical picture (Monroe and Mineka, 2008). These findings raise the possibility that in OUR study, traumatic experiences after 9/11 and current distress and symptoms might confound memory and recall and/or interpretation of past trauma. Therefore, people exposed to traumatic experiences after 9/11 might report more symptoms of PTSD.

5.2.3.1 Parents' Role in Children's Expressions of Distress

The strong effect of restricted freedom to travel around NYC and PTSD deserves further attention. Parents play an important role in adolescents' adjustment following traumatic events (Eisenberg and Silver, 2011). After a disaster or traumatic experience, posttraumatic symptoms and psychological

distress among children have been associated with their parents' posttraumatic stress symptoms, distress, and fears about possible future negative events, even after controlling for objective characteristics of the event (Eisenberg and Silver, 2011). The current findings are consistent with research finding children who develop an anxiety disorder are more likely to have parents who promote and encourage avoidant behavior. Preventing children from freely moving about may deny them important corrective emotional experiences that can attenuate inflated perceptions of personal risk and general negative affect. In addition, disrupting children's normal activities may encourage social withdrawal and isolation, both associated with increased risk for the development of internalizing symptoms. Moreover, parental restriction of children's travel may reflect parental fears and anxiety, and thus the present findings may reflect the transactional relationship between parent and child adjustment following a disaster (Comer et al., 2010).

5.3 PTSD and MDD

One of the purposes of the current study was to determine independent predictors of PTSD and MDD. If PTSD and MDD 6 month after 9/11 are, indeed, different constructs, then their diagnostic group should be a function of differential groups of predictors. As previously discussed, a combination of variables was able to differentiate PTSD from no diagnosis. On the other hand, MDD was not differentiated from no diagnosis by the same predictors, with few exceptions. Importantly, variables related to exposure to 9/11 were significant risk factors for PTSD in the final model, but were not associated with MDD. Thus, as far as PTSD and MDD are involved, there seem to be support for DSM Criterion A, which establishes a unique relationship between traumatic exposure and PTSD.

Furthermore, items significantly associated with PTSD remained significant after adjusting for MDD, suggesting that those variables act as risk factors for PTSD independently of MDD. On the other side, when the final model with MDD as the outcome was adjusted for PTSD, the strength and significance of the association between MDD and its risk factors diminished substantially. This finding might suggest that part of the association between MDD and the predictors included in the analysis is accounted for by PTSD risk. However, the associations between MDD and its predictors were still significant or marginally significant after adjusting for PTSD.

Thus, there is evidence to suggest that, in the six months following 9/11, PTSD and MDD may exist as two separate and independent clinical entities. It should be mentioned that it is important be cautious in concluding that the two conditions are the same or different based solely on the similarities of factors predicting them. While it is the case that identification of different risk factors clearly implies that two conditions are distinct, the opposite is not necessarily true. That is, distinct conditions may share identical risk factors. However, although demonstration of similar correlates is not conclusive, it certainly serves to narrow the focus for future research designed to establish whether the conditions are, in fact, different.

5.4 PTSD symptom structure

LCA was applied to data from 6,733 children and adolescents who experienced at least one event related to direct, indirect, or media exposure to the WTC attack. Initially, LCA fit to the 8 DPS PTSD symptoms identified a 4-class solution as the most parsimonious and best fitting model in the whole sample. Classes varied in severity, with 10% of subjects exhibiting severe disturbance (Class4), 40% exhibiting intermediate disturbance (Class 2 and 3; 23% and 17% of subjects, respectively) and 50% of subjects characterized by no disturbance (Class 1). Compared to other classes, the severe disturbance class had ORs of probability of symptom endorsement significantly greater than 1 for every PTSD symptom (with the only exception being D7 compared to Class 3). This evidence seems to suggest that the endorsement of the whole set of DPS PTSD symptoms, rather than just one symptom (eg, recurrent thoughts) or a cluster of symptoms (eg, avoidance), mostly distinguishes the pervasive disturbance class from classes with less severe symptom profiles. Recurrent thoughts of what happened or what the individual saw on 9/11 is the symptom with the highest prevalence in every class, with no significant differences across classes. Therefore, this symptom doesn't indicate a high specificity in identifying subjects with more severe symptomatology. The higher frequency of this symptom compared to other PSTD symptoms is consistent with the literature. For example, Copeland et al. (2007) examined the developmental epidemiology of potential trauma and PTS in a longitudinal representative population sample of 1420 children from western North Carolina, aged 9, 11, and 13 years at intake and followed up annually through 16 years of age. Full-blown DSM-IV PTSD (meeting all diagnostic criteria for DSM-IV PTSD) was rare across all sex, age, and ethnic groups, with a weighted prevalence of 0.5%. However, painful recall and subclinical PTSD (endorsing at least 1 symptom each of painful recall, hyperarousal, and avoidance symptoms but not meeting full PTSD criteria) were more common, with cumulative rates of 9.1% and 2.2%, respectively, by 16 years of age in the full sample. Averaging 3-month and lifetime prevalence rates, about 1 of every 10 subjects exposed to trauma reported painful recall and about 3% reported subclinical PTSD. Subjects with intermediate levels of disturbance are divided in two classes (class 2 and 3), mostly on the basis of the higher prevalence of sleep-related problems (Nightmares and Insomnia) in class 2 and of avoidance of activities, places, and people in class 4.

To our knowledge, we are the first to provide a representation of quantitative and qualitative differences in PTSD symptom profiles between genders in children and adolescents (age range 8-20). In accordance with the evidence previously reported in community-based studies of adolescents and young adults(Ayer et al., 2011; Breslau et al., 2005; Chung and Breslau, 2008), the current findings further support the identification of classes that reflect distinct groups along a continuum of PTSD symptom severity. The main difference with respect to previous findings might be the identification of four classes rather than three. The larger sample size might have allowed for the identification of two different patterns at the

intermediate level of severity. From this perspective, the evidence of four classes is not in contrast with previous studies, and rather represents a replication and an extension of previous findings.

Exploiting the large sample size, LCA was applied to subgroups stratified by gender and age. LCA revealed that females, and in particular girls older than 13, have higher probability of belonging to the classes of severe disturbance and intermediate disturbance with avoidance symptoms, compared to boys in the same age range. These findings further support the need to consider developmental factors in the diagnosis and treatment of PTSD. This is also consistent with the previous PTSD(Ayer et al., 2011) literature and more, in general, with anxiety and mood disorders that show how prevalence of psychopathology changes substantially during childhood and adolescence.(Angold and Costello, 2006; Costello et al., 2005; Kendler et al., 2008; Last et al., 1996; Twenge and Nolen-Hoeksema, 2002; Weissman et al., 1999). In a developmental perspective, changes in the levels of anxiety and depression and prevalence of anxiety and mood disorders during childhood and adolescence are consistent with the evidence that the genetic effects on symptoms of anxiety and depression are developmentally dynamic from middle childhood to young adulthood, demonstrating both genetic innovation and genetic attenuation (Kendler et al., 2008). The low levels of continuity of anxiety and depressive disorders from childhood to adulthood could be reflected also in a developmentally dynamic expression of PTSD symptomathology. Interestingly, Kendler et al (Kendler et al., 2008) showed also that the genetic influences on symptoms of anxiety and depression in males and females are very similar in childhood; however, the correlation between genetic risk factors for symptoms of anxiety and depression in males and females tends to decline during development. As pointed out by the authors, a possible explanation for these results is a partial moderation of the genetic influences on anxiety and depression by gonadal hormonal exposure, which becomes increasingly divergent in males and females after puberty(Kendler et al., 2008). The authors support their explanation with prior research showing 1) evidence that the prevalence difference in major depression in the sexes appears at puberty and is linked more directly to changes in gonadal steroids than in morphological changes, 2) findings in adult samples that genetic risk factors for major depression are only partly correlated in males and females, and 3) multiple findings in animals and human that gonadal hormones influence multiple neurobiological systems that potentially impact on levels of mood and anxiety. Importantly, Kendler et al (2008; p 1573) point out that "molecular genetic studies of anxiety and depression during development will need to move beyond static models to capture the true complexity of gene action". The authors provide as an example a recent molecular genetic study that showed, across multiple large samples, a gene by age interaction for a single nucleotide polymorphism (SNP) in the gene *ROBO1* (Lasky-Su et al. 2008). The CC genotype of this SNP was strongly related to obesity early in life but the magnitude of this association declined substantially with age, exactly the pattern expected given genetic attenuation.

Three subgroups of individuals were identified mainly characterized by direct, indirect and media exposure to 9/11. Previous studies on nationally representative samples used LCA to capture adequately the heterogeneous nature of complex patterns of exposure at the individual level rather than using single variables to represent cumulative exposure.(Houston et al., 2011; Shevlin and Elklit, 2008) In the presence of severe disturbance, individuals who were grouped in the class of Indirect Exposure were more likely to report PTSD symptoms, especially symptoms of avoidance and insomnia, compared to those in the Direct and Media Exposure classes. Interestingly, both the Indirect Exposure and the Media exposure subgroups show higher prevalence of severe PTSD symptom profiles, compared to the Direct Exposure subgroup. The less severe symptoms profile associated with direct exposure may also be a function of the length of time between 9/11 and the assessment (6 months); It is likely that more immediate effects of direct exposure events (with the exception of being physically hurt) on youth probable PTSD might have largely diminished with time, while the more prolonged exposure associated with media coverage and the long term consequences of having family members killed or hurt in the attack might still exert a significant effect 6 month after 9/11. The higher prevalence of severe PTSD symptom profile in the indirect exposure subgroup is consistent with evidence reported previously in the literature of risks of posttraumatic stress reactions in the same sample as the current study(Hoven et al., 2005a; Rosen and Cohen, 2010) as well as in different studies conducted after other man-made(Pfefferbaum et al., 2000; Pfefferbaum et al., 1999; Pfefferbaum et al., 2003a; Scheeringa et al., 2010) and natural disasters.(Hsu et al., 2002) The higher prevalence of severe PTSD symptom profile in the Media Exposure subgroup further support the hypothesis of the bidirectional relationship between PTSD symptomatology and media coverage, since those who are more symptomatic may have stronger reactions to media exposure and may be drawn to the media coverage to obtain information or maintain a heightened state of arousal.(Pfefferbaum et al., 2003b; Roussos et al., 2005a)

Unlike Ayer and colleagues(Ayer et al., 2011), the global measure of functional impairment used here was not specifically linked to any specific disorder.(Bird et al., 2005) In this sample, the presence of traumatic memories only, or traumatic memories in combination with either avoidance symptoms or sleep-related problems is apparently not sufficient to generate a clinically meaningful PTSD profile; what appears to be necessary is the combination of these three elements.(Chung and Breslau, 2008) (Ayer et al., 2011)LCA applied to PTSD symptoms and impairment indicators identifies only one class defined by high levels of PTSD and impairment, characterized also by high rates of probable MDD, SAD and CD. We found also a class with high levels of impairment associated with high rates of probable disorders not comorbid with PTSD.(Bird et al., 2005) The findings on the presence of severe PTSD symptomatology and other probable disorders (MDD, SAD and CD) in the same class support the need for future studies in the same sample to better identify patterns of comorbidity.

Several limitations should be noted. First, DPS PTSD items were about reactions to the WTC attack, to which the respondent could have been exposed directly, indirectly or through the media. However, the objective DSM-IV component of trauma (criterion A1) was not thoroughly investigated, and the subjective component (criterion A2) was not assessed; thus, 9/11-related events can be only considered as potentially traumatic events. Second, given that the DPS was designed for screening purposes, selecting the most informative symptoms, DPS PTSD items do not cover completely the full range of DSM-IV PTSD symptoms. Therefore, comparison of the findings with previous studies on the latent structure of PTSD can only be tentative. Finally, as a consequence of these limitations, PTSD is here considered as probable, and not a definite disorder.

Altogether, the current study extends previous work on latent structure of PTSD to a large community-based representative sample of 6,733 trauma-exposed children and adolescents, in an age range from 8 to 20. The findings substantially corroborate the evidence of a continuum of PTSD symptoms' severity. Furthermore, leveraging the significant sample size and the unique shared exposure and the availability of children, our findings highlight age- and gender-related manifestations of PTSD symptomatology, in a critical period during development. In this perspective, the current study can be informative to DSM-V, as it shows a more dimensional and quantitative approach to the assessment of PTSD severity, and it confirms that the inclusion of developmentally informed diagnostic criteria should be a high priority.

5.5 Comorbidity

High rates of comorbidity were found among disorders. Psychopathology is strongly interrelated with trauma and trauma symptoms. Across childhood, the children who experience trauma are often those with anxiety, depressive and disruptive behavior disorders (Copeland et al., 2007). This likely reflects common liability conveyed from a limited set of family risk factors (Kendler et al., 2003). Furthermore, psychopathology, particularly depression and anxiety, can serve as a risk for and sequela of trauma exposure (Kendler et al., 2004; Bolton et al., 2004) (Copeland et al., 2007). Copeland et al. (2007) showed some specificity in the role of psychopathology as risk for trauma and trauma exposure. Past depression best predicted first trauma, but it was a history of anxiety disorders that best predicted PTS symptoms in response to trauma exposure. A similar effect for anxiety was found in a recent community-based prospective study of 1,698 children followed into young adulthood (Storr et al., 2007). Asarnow et al. (1999) showed that PTSD symptoms 1 year after the Northridge earthquake in the Los Angeles area were significantly associated with a pre-earthquake anxiety disorder. Children reporting high rates of PTSD symptoms also reported high rates of concurrent general anxiety symptoms, depressive symptoms, and social adjustment problems with friends. To account for the role of predisaster anxiety in mediating long-term distress among subjects with mild to moderate exposure, the authors hypothesized that, under conditions of mild to moderate exposure, traumatic feauture of the event may account for less of the

variance in children's reaction; children with preexisting anxiety may be prone to more extreme subjective appraisal of threat, be less able to bring adequate secondary reappraisal mechanisms into play, and derive less comfort from efforts at safety improvements and personal reassurances (Asarnow et al., 1999). Since preexisting psychiatric disorders (with onset before 9/11) were not assessed in the NYC-DES, it is not known if children with pre-existing conditions were at higher risk of developing PTSD and other disorders after 9/11. It should be noted that due to the unpredictable nature of 9/11, it is unlikely that preexisting psychiatric disorders could have influenced the likelihood of exposure. However, the possibility remains that children with preexisting conditions could have been more vulnerable to the detrimental effects of the WTC attack. Furthermore, respondent exposed to non-observed traumatic events before 9/11 could have been at increased risk of developing PTSD (or other disorders) after exposure to 9/11; also, non-observed preexisting psychopathology could have increased the likelihood of being exposed to traumatic events before 9/11, further increasing the risk of developing PTSD as a consequence of 9/11.

5.5.1 Latent structure of PTSD symptoms and comorbid psychopathology

The aggregation of childhood psychiatric symptoms and disorders in the NYC-DES was assessed through latent class analysis (LCA). As PTSD is a multifaceted disorder characterized by problems of re-experiencing, avoidance and numbness, and increased arousal, description and evaluation of disorders and symptoms of other disorders occurring with PTSD are complex. True comorbidity may occur as a result of overlapping symptomatology, one disorder manifesting itself as an earlier form of the other, or from shared risk factors. Assessment of the underlying structure of disorders commonly co-occurring with PTSD may help to discriminate natural symptom aggregation across PTSD domains and provide insight into the cause of comorbidity (Volk et al., 2005).

As previously said, factor analytic studies have characterized observed co-occurrence among common mental disorders in terms of two correlated but distinct factors of internalizing (subsuming two interrelated subdimensions of "fear" and "anxious-misery") and externalizing (antisocial and addictive disorders). However, the basis of the moderately large correlation between factors of internalizing and externalizing (ie, the sources of overlap between disorders in one domain and the other) remains unclear. LCA is a complementary approach to understanding comorbidity. Modeling data with LCA might help reveal what people with comorbid internalizing and externalizing psychopatholgy look like (Vaidyanathan et al., 2011).

LCA yielded 6 latent classes exhibiting distinctive profiles of diagnostic comorbidity: a distress class (depression, generalized anxiety disorder), an externalizing class (conduct disorder), a multimorbid class (highly elevated rates of all disorders), 2 classess of intermediate disturbance and a low disturbance class (very low probability of all disorders). Some disorders were relatively specific to certain classes; for

example, PTSD was specific to the multimorbid class. Others disorders appeared to be evident across classes. For example, MDD was frequent in the multimorbid class and in the distress class; interestingly, CD was frequent not only in the externalizing class, but also in the distress class. When problem-drinking was added to the LCA models, it occurred almost exclusively in the externalizing class.

Importantly, the results are in accordance with a previous study that used LCA to examine the patterns of comorbidity among 11 disorders in two nationally representative epidemiological adult samples (Vaidyanathan et al.). LCA identified 5 latent classes: a distress class (depression, generalized anxiety disorder, dysthymia), an externalizing class (alcohol and drug dependence, conduct disorder), a multimorbid class (highly elevated rates of all disorders), and a few-disorders class; a fear class (all phobias and panic disorder) was also identified, but couldn't be replicated in the NYS-DES because phobias were not assessed and PD was assessed with only two items. This pattern of results indicates that these latent classes do not reflect subsets of individuals who differ simply in overall severity of mental illness, but rather distinct groups of individuals prone to differing combinations of disorders.

The results are in accordance also with previous research that has examined comorbidity using factor analysis (Forbes et al.; Krueger; Slade and Watson; Vollebergh et al.). Surprisingly, all of these studies were conducted in adults samples, so comparison of findings is difficult. Nevertheless, in parallel with the models specified in these studies, distinct patterns of comorbidity were evident among individual participants in the current study, reflecting systematic coherency among disorders entailing high levels of distress and dysphoria (GAD and MDD) and among symptoms involving deficient impulse control (conduct disorder, and problem-drinking when added to the models). In addition, and more importantly, a class emerged that has not been identified before in children, the multimorbid class. This class emerged as the smallest of the six classes; and it was clearly associated with the greatest overall severity of psychopathology, in terms of high probabilities of endorsement for all internalizing disorders. However, rates of PTSD, SAD and Agoraphobia were twice as high compared to rates of GAD and MDD; in the context of a sample of children and adolescents assessed 6 months after 9/11, this result is interesting because it suggests that disorders characterized by fear are the most prominent in the most severe class. The role of the brain fear cicuit in PTSD is well establishd. A recent neurocircuitry model of PTSD hypothesizes hyperresponsivity within the amygdala to threat-related stimuli, with inadequate top-down governance over the amygdala by the ventral/medial prefrontal cortex (vmPFC) and the hippocampus. Amygdala hyperresponsivity mediates symptoms of hyperarousal and explains the indelible quality of the emotional memory for the traumatic event; inadequate influence by vmPFC underlies deficits of extinction as well as the capacity to suppress attention and response to trauma-related stimuli; and decreased hippocampal function underlies deficits in identifying safe contexts, as well as accompanying explicit memory difficulties (Rauch et al., 2006). Consequently, the pathogenesis of PTSD can be

conceptualized as a fear-conditioning process that is superimposed over some diathesis, which could entail any combination of premorbid intrinsic amygdala hyperresponsivity, vmPFC deficiency, hippocampal deficiency, or exaggerated susceptibility to stress (Rauch et al., 2006). In addition, as a consequence of trauma, younger children may tend to maximize physical or emotional proximity to a parent or caregiver for social referencing, an added measure of protection, and monitoring of the safety of a parent/caregiver (Pynoos et al., 2009), and develop fears involving the theme of separation. Finally, school age children may manifest several incident-related new fears, such as agoraphobic fears.

In addition to providing converging evidence for distinct domains of psychopathology marked by excessive fear or pervasive distress (internalizing disorders) or by deficient impulse control (externalizing disorders), the current work also sheds new light on a key unanswered question emerging from factor analytic studies, related to the cause of overlap between internalizing and externalizing disorders, reflected in moderate-to-high correlations among factors and subfactors in dimensional models of comorbidity. The current findings point to two systematic sources for this overlap. One of these pertains to elevated rates within the distress and externalizing classes of what others have termed *cross-class disorder;* that is, disorders evident at elevated rates in several classes (Vaidyanathan et al., 2011). In both the distress and externalizing classes, CD had a high frequency. This overlap might be caused by older respondents. As a consequence of trauma, adolescents may be propelled into greater independence and misjudgments about danger and protective action that can result in reckless or high-risk behaviors; in addition, the neural signature of achieving safety engages the reward centers of the brain that are also involved in substance abuse and thrill-seeking behavior, an especially relevant consideration in regard to adolescents and young adults(Pynoos et al., 2009). The other source consists of a distinctive subgroup of subjects exhibiting heightened rates of all disorders from both the internalizing and externalizing domain (multimorbid class). Across the two study samples, individuals in this class showed 1) the highest rates of PTSD, SAD and agoraphobia, and 2) rates of MDD and GAD comparable to those observed in the distress class, along with the highest rates of PTSD compared with all classes; and (3) rates of CD that substantially exceeded rates in other classes aside from the externalizing and distress class. These observations, by highlighting major ways in which individuals in the multimorbid, distress, and externalizing classes manifest particular disorders characteristic of other classes, suggest ways to account for the overlap that exists between internalizing and externalizing domains.

Finally, Vaidyanathan at al (Vaidyanathan et al., 2011) made important points on how to interpret and understand the phenomenon of comorbidity using results from previous factor analytic work and results from LCA. The purpose of the of applying LCA to symptoms of psychiatric disorders was to provide a complementary descriptive perspective on psychopathology by examining how comorbidity could be understood when examined as clusters of persons occurring along dimensions of psychopathology.

Results from the current study suggest that certain forms of psychopathology appear to "link" the dimensions, beyond the contribution of a multimorbid class. The results might support the existence of latent classes of mental disorders. For example, it could be hypothesized that the classes obtained in the current study are "syndromes" reflecting "facets of the same clinical entity"(Vaidyanathan et al., 2011). In addition, Vaidyanathan et al (Vaidyanathan et al., 2011), quoting other authors, suggest that psychopathology may indeed be "intrinsically heterogeneous," with "'true diseases' (such as general paresis), which have clear boundaries among themselves and with normality; 'circles' (such as manic-depressive insanity and schizophrenia), which have clear boundaries with normality but not among themselves; and 'types' (such as neuroses and abnormal personalities), which do not have clear boundaries either among themselves or with normality." Results from the current study support such an interpretation.

5.5.1.1 Implications

The current findings have implications for traditional conceptions of mental disorders as discrete, etiologically coherent entities. . In line with findings from previously mentioned structural modeling studies, symptoms of common mental disorders were found to co-occur in distinctive patterns, consistent with the idea of shared etiologic underpinnings to differing disorders. These results can also be interpreted in light of findings from twin studies, keeping in mind that only two studies included PTSD (Tambis 2009)(Wolf et al., 2010), and that these two studies were conducted in adults. Wolf et al (Wolf et al., 2010) recently modeled the relative strength of genetic and environmental influences on the common factors underlying the internalizing and externalizing dimensions of psychopathology. Analyses revealed that 41% of the variance in the common factor underlying disorders of the internalizing spectrum was accounted for by one genetic factor, whereas a second, distinct, genetic factor explained 40% of the variance in externalizing. These findings suggest that genes contribute in a broad and coherent manner to increase the likelihood of developing one or more of a range of related mental disorders. The first genetic factor likely corresponds to the heritable component of trait negative emotionality and is likely manifested in symptoms marked by high distress but little specificity for any single DSM diagnosis; Watson et al (Watson, 2009) talk about 'generalized distress', a concept similar to the one of a multimorbid class previously mentioned. The second factor may reflect the heritable component of trait disinhibition (i.e., the primary personality substrate for externalizing. This dimension may manifest cognitively in executive function deficits, particularly in the domain of response inhibition(Wolf et al., 2010). Most importantly, analyses also revealed evidence of substantial genetic effects that were shared between the two dimensions of psychopathology, with 29% of the variance in Externalizing accounted for by the first genetic factor; this suggests that the biological risk factors for the development of internalizing and externalizing disorders are not fully distinct and implies that some genes may increase the risk for

disorders in both spectrums. This overlap is consistent with prior studies of the phenotypic structure of comorbidity that have found moderate correlations between internalizing and externalizing factors (Forbes et al.; Krueger; Slade and Watson; Vaidyanathan et al.; Vollebergh et al.)) and with findings from the NYC-DES. This likely reflects the contribution of negative emotionality to both spectra and illustrates the ubiquity of negative emotionality in mental disorders (Khan et al., 2005). Focusing on anxiety disorders, Tambs et al (Tambs et al., 2009)found that a single factor could explain the observed comorbidity between lifetime diagnoses of the five anxiety disorders included. Also, the authors found that a common anxiety liability pathway underlying all 5 disorders fitted the data well. The latent liability common to all anxiety disorder scores was substantially heritable (54%) with only a minimal and non-significant estimated contribution from the shared environment. Importantly, all five anxiety disorder scores derived the majority of their genetic risk from the common factor.

In this context of attempting to understand interrelations among psychopathology from differing perspectives, it is worth noting that there has been a recent effort to develop a "metastructure" of mental disorder clusters for the upcoming version of the DSM (*Psychological Medicine*, December 2009 special issue). However, a point acknowledged by several contributing authors, was that further empirical evidence is required to support a move in this direction (*Psychological Medicine*, December 2009 special issue). Results from the current study could contribute to such efforts from the perspective of latent variable modeling. Findings of this study help clarify the location of PTSD within the broader structure of common mental disorders. Twin studies have shown a significant relationship between PTSD and disorders of both the internalizing and externalizing spectra; in other words, the best fitting model included significant loadings of PTSD on both internalizing and externalizing latent factors (Wolf et al., 2010). For example, Wolf et al (2009) have shown that PTSD covaries more strongly with disorders of the internalizing spectrum; however, their results also demonstrated a significant relationship with externalizing disorders that was important to overall model fit. No other internalizing disorder yielded this same pattern of cross-loading on the externalizing factor, suggesting the discriminant validity of the PTSD–externalizing association relative to the other internalizing disorders (Wolf et al 2009). As pointed out by the authors, this finding is consistent with a "multiformity" model in which PTSD is conceptualized as arising as a function of latent liabilities toward either internalizing or externalizing. In addition, PTSD evidenced a much weaker association with the Internalizing factor relative to the magnitude of the loadings of the other internalizing disorders on that factor, a finding which has been reported previously. Wolf et al (2009) conclude that their findings add to a growing body of research which call into question the current placement of PTSD within the anxiety disorders section of DSM (Resick & Miller, 2009). They are consistent with the hypothesis that PTSD may arise from individual diatheses that span the spectrum of human variation in vulnerability to psychopathology and result in

extensive heterogeneity in the phenotypic expression of posttraumatic psychiatric disturbance. They also support calls for PTSD to be moved out of the anxiety disorders in DSM–V into its own class of disorders defined by the causal conditional nature of their relationship to serious adverse life events (i.e., a spectrum of traumatic-stress disorders; Resick & Miller, 2009). The LCA results have an implication for the structure of anxiety disorders in the fifth edition of the DSM. Despite strong evidence that PTSD has a strong relationship with externalizing disorders, the LCA results show that PTSD symptoms in the severe internalizing class are related most strongly related to internalizing psychopathology. Thus, genetic findings alone cannot justify its removal from the anxiety disorders. Furthermore, the genetic relationship between PTSD and other internalizing disorders may be non-specific and indicative of a broad shared genetic liability across a wide range of internalising disorders.

LCA results have implications also for genetic studies of psychiatric disorders. For example, genome wide association studies (GWAS) have yielded many important findings with respect to several human conditions; however, identification of novel genetic determinants of psychiatric diseases via GWAS studies has been more challenging; furthermore, replication of findings has been difficult(Bloss 2010). One of the reasons for the lack of consistency and compelling findings in genetic studies of neuropsychiatric disease relates to phenotypic heterogeneity and the notion that there is simply inherent imprecision associated with diagnostic categories in psychiatric disease. Clinical heterogeneity most likely reflects etiological heterogeneity. Traditional categorical diagnostic criteria for neuropsychiatric disorders as delineated by the DSM essentially serve to place affected individuals into discrete, diagnostic categories despite the fact that individual members of a category typically possess highly complex and heterogeneous clinical, behavioral, and neurocognitive profiles. Thus, because most GWAS studies of psychiatric disorders have defined the phenotype according to these simplified diagnostic categories in service of case/control study designs, critical phenotypic information is not leveraged, which likely results in decreased statistical power to detect an effect. Ignoring phenotypic heterogeneity in genetic association studies of neuropsychiatric disease is particularly problematic given that genes are not likely to encode for categorical ‘diagnosis’, but rather are likely to be associated with specific symptoms or clusters of psychiatric symptoms (e.g., irritability), which can be present across multiple diagnostic categories (e.g., PTSD, MDD, CD). Therefore, the search for genes that mediate heterogeneous and imprecise clinical diagnostic categorizations may be ill-conceived and should be replaced, or at least extended, by genetic studies that leverage behavioral profile-based phenotypes(Bloss 2010). The identification of homogeneous groups through LCA might facilitate gene discovery.

Finally, LCA results can be a useful tool for case finding. Case finding is a significant challenge in delivering mental health services after natural disasters, industrial disasters, or terrorist attacks (Rosen and Cohen, 2010). Most people who experience acute distress after a disaster return to normal functioning

within six months to a year after the event. However, a significant minority of those who are distressed continue to have enduring symptoms and problems months or years after the event. Children and teens are especially likely to have emotional difficulties after disasters. However, children and adults who have mental health problems after a disaster often go undetected, undiagnosed, and untreated. Disaster mental health programs in the United States typically use proactive outreach efforts to try to penetrate all segments of the affected community; such universal outreach is somewhat inefficient, because most people who receive outreach contacts would recover spontaneously without any mental health services(Rosen and Cohen, 2010). Outreach to the entire affected community may be a reasonable case-finding strategy in localized disasters that have an impact on a circumscribed community. However, universal outreach is a less effective case-finding strategy when responding to events that have an impact on millions of people. When responding to such massive events, it is critical to target with finite mental health outreach and treatment resources the most affected groups. Therefore, LCA on epidemiological data could be useful to identify different classes of severe symptomatolgy, which should be give priority in intervention effort. In addition, different symptoms profiles and combination across classes of severe disturbance might required different intervention protocols.

5.6 Item response theory

PTSD symptom criteria were investigated as the field embarks on revision of the DSM. Examining the symptom criteria in community samples of children adolescents versus clinical samples is useful because it allows assessing the extent to which the criteria indicate severe pathology. The IRT analyses can provide information regarding the extent to which the DSM symptom criteria may be useful for the dimensional scaling of traits, the range of item severities that are indicated by the current criteria, and the extent to which the symptom criteria function similarly across distinct groups (e.g., younger girls vs older boys). The results suggest that 1) DPS PTSD criteria are most informative at an intermediate level of severity; PTSD-RI criteria (with 0/1/2 answers coded as negative and ¾ answers coded as positive) are instead most informative at most severe levels of the latent PTSD trait, 2) PTSD criteria may be useful for dimensional scaling of PTSD, and 3) there are differences in criteria functioning across groups defined by gender and age (≤13; ≥14).

5.6.1 PTSD criteria are informative for intermediate (DPS) and severe (PTSD-RI) levels of PTSD

The severity of the PTSD criteria, that is, the level of severity at which the criteria are most informative, varies considerably for DPS items (from −1.26 to 1.99); the severity PTSD-RI items is instead fairly uniform across the upper range of PTSD problems (from 1.33 to 2.07). Overall, the set of DPS PTSD criteria and PTSD-RI criteria is not suitable for identifying subjects with very severe PTSD, but may be more useful if dimensional scaling across the lower range of severity of the latent trait is desired (e.g.,

screening of large epidemiological studies like the current one). A major exception to the relative uniformity of the item severity parameters exists for the DPS criterion "Recurrent thoughts" which had an extremely low item severity parameter. This behavior may be considered as normative six months after 9/11, rather than as a criterion for a psychiatric disorder. It should be noted that this criterion had very low severity only in the DPS (-1.26); its counterpart in the PTSD-RI had a severity value of 1.33. This is important, because it could be argued that simply asking (as in the DPS) about the presence vs absence of a symptom (yes/no) tend to produce many false positives and overestimate the presence of a symptom; on the contrary, answers ordered on a likert scale (PTSD-RI) could be more informative, especially for self-administered questionnaires; in this case, considering as positive only "much" or "most" answers could increase the power of a questionnaire to identify more severe cases or true positives. In contrast, in a dimensional scaling system, this criterion may be important, when comparison with mean levels of the trait is desired.

5.6.2 PTSD IRT parameters and dimensional scaling

The combined TIC presented in Figure 25 demonstrates that the PTSD symptom criteria tap a range of the latent PTSD trait, providing the most information on severity of the latent PTSD trait for those who are between 0.5 to 2 SDs above the mean (DPS), and between 1.0 to 2.5 SDs above the mean (PTSD-RI, with 3/4 answers considered as positive). The TIC peaked slightly above 1 SDs above the mean for DPS PTSD items, and slightly below 2 SDs above the mean for PTSD-RI items, suggesting that dimensional scaling on this latent PTSD with PTSD-RI items is more appropriate for more severe individuals, while dimensional scaling on the latent PTSD trait with DPS items is more appropriate as the severity of disorder decreases. Overall, these two TICs are not appropriate for a set of psychiatric symptom criteria that are intended only to identify and distinguish the most severely affected individuals. These two TICs are more appropriate for a dimensional scaling of posttraumatic stress reactions across a broader range of the latent trait. Furthermore, this approach may allow for earlier "indicators" of pathology and better dimensional scaling across the range of the latent trait. If DSM-V is to incorporate both dimensional and categorical scaling of posttraumatic stress reactions, addition of lower item severity criteria might be necessary (Gelhorn et al.).

There may be additional information available from the response patterns compared with information obtained by simply summing the number of criteria endorsed. For example, a patient who answers to the PTSD-RI and endorses items such as recurrent thought of what happened during exposure and psychological reactivity at exposure to trauma-related cues may be considered of lower severity on the latent PTSD trait than a subject who reports avoidance of activities, places and people that arouse recollection of the trauma and feelings of detachment and estrangement from others. The first case endorsed the 2 least severe PTSD-RI criteria, whereas the second case endorsed 2 of the more severe

criteria with item severity parameters above or close to 2 SDs above the mean. While this additional information might be burdensome for diagnostic purposes, it may prove useful for treatment or research. Additionally, a useful application of the IRT-based item parameters could be employed in the absence of disclosure from patients. External reports of behaviors (e.g., specific symptoms or behaviors), though imperfect, may be considerably more informative in the context of the item characteristics. This limited information may provide at least a rough assessment of PTSD in people for whom limited information is available due to unwillingness to cooperate with clinicians or interviewers, absence, or other reasons. For example, knowledge that a child avoids activities, places or people associated with the trauma might suggest severity of latent PTSD trait greater than 2 SD above the mean (based on E7 item severity parameter 2.07).

5.6.3 PTSD criteria display differences across groups defined by sex and age

In general, PTSD criteria do not seem to provide the same information across subgroups defined by gender and age. Differences in item functioning across groups do not automatically imply that the criteria should be eliminated from the DSM criteria or from a screening or diagnostic questionnaire. DIF may indicate real differences in the criteria based on sex and gender, or alternatively, DIF may indicate that the criteria are poorly operationalized or worded. Researchers attempting to improve clinical criteria may choose to rework these criteria to more precisely target the construct of interest, or conversely, seek to examine whether biological and/or social factors are contributing to the observed differences. Importantly, DIF might have substantial clinical implications. First, it emphasizes that certain PTSD symptoms are more likely than others to represent severe posttraumatic stress reactions in different groups. Thus, while endorsement of PTSD-RI item E8 (recurrent nightmares) may be almost normative in younger (8-13) girls, the same item in older (14-21) boys may be more indicative of severe PTSD. Clinicians should consider both the item severity (i.e., the severity of endorsed behaviors) and the patterns of symptom endorsement of PTSD patients when assessing the disorder, and not focus solely on the diagnostic status. The results suggest that future editions of DSM might successfully incorporate a more dimensional model of PTSD symptoms, which (especially in developing individuals) might include useful consideration based on age and gender. For example, symptom threshold cutoff values and symptom endorsement patterns might be considered conjointly and viewed as complimentary and mutually valuable sources of information.

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