NEUROPSYCHOLOGICAL FUNCTIONING IN CHILDREN WITH POSTTRAUMATIC STRESS DISORDER

Kristin W. Samuelson,1 Casey E. Krueger,2 Christiane Burnett,1 and Christina K. Wilson1

1California School of Professional Psychology at Alliant International University, San Francisco, CA, USA, 2Department of Neurology, University of California–San Francisco, CA, USA

Posttraumatic stress disorder (PTSD) has been associated with deficits in the areas of verbal memory and learning, executive functioning, working memory, and attention in adults. Findings have been less consistent in the few studies examining neuropsychological functioning in childhood PTSD, which are often limited by comparing children with PTSD to children without trauma histories, making it unclear whether observed neuropsychological deficits are related to trauma exposure or to PTSD symptomatology. In an ethnically diverse sample of 62 children who witnessed intimate partner violence (n = 27 PTSD+ and 35 PTSD−), children with PTSD exhibited slower and less effective learning, heightened sensitivity to interference, and impaired effect of rehearsal on memory acquisition on the California Verbal Learning Test – Children’s Version, a word list learning task. Both groups performed in the below average range on measures of executive functioning, attention, and intellectual ability.

Keywords: PTSD; Children; Memory; Executive functioning; Intimate partner violence.

The witnessing of intimate partner violence (IPV) is a common source of trauma exposure for children (Straus, 1992), resulting in posttraumatic stress disorder (PTSD) in 20% of cases (Mertin & Mohr, 2002) and leading to potentially serious consequences in child development. Interactions between trauma exposure, stress responses (e.g., PTSD), and neurodevelopmental processes can lead to profound negative effects on a child’s neurobiological, neuropsychological, social, emotional, and behavioral development (De Bellis, 2001; De Bellis & Putnam, 1994). Understanding the impact of PTSD symptoms on neuropsychological functioning of children exposed to trauma is a much needed area of research.

While many studies have examined the effects of PTSD on neurobiological and neuropsychological functioning in adults, research with childhood PTSD has only recently begun to emerge. Studies examining adults with PTSD have reported deficits in the areas of verbal memory and learning, executive functioning, working memory, and/or attention (Gilbertson, Gurvitz, Lasko, Orr, & Pitman, 2001; Golier & Yehuda, 2002; Horner & Hamner, 2002; Koenen et al., 2001; Samuelson et al., 2006; Uddo, Vasterling, Brailey, &

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Address correspondence to Kristin W. Samuelson, PhD, California School of Professional Psychology at Alliant International University, One Beach Street, Suite 100, San Francisco, CA 94133. E-mail: ksamuelson@alliant.edu

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Sutker, 1993; Vasterling, Brailey, Constans, & Sutker, 1998; Vasterling et al., 2002; Yehuda et al., 1995), as well as structural and neurobiological abnormalities associated with PTSD (see Southwick, Rasmussen, Barron, & Austen, 2005 and Karl et al., 2006 for reviews). Early adult PTSD studies focused on identifying neuropsychological deficits associated with PTSD, and researchers have only recently begun to question whether such deficits represent a preexisting risk factor in the development of PTSD or represent an outcome of PTSD (Gilbertson et al., 2006).

Researchers have more recently turned to the task of understanding the impact of PTSD on children’s developing brains and subsequent neuropsychological functioning, through the identification of associations between PTSD, structural and neurobiological abnormalities, and neuropsychological deficits. There is evidence of diffuse central nervous system (CNS) effects, including smaller cerebral volumes and corpus callosum areas (Carrion et al., 2001; De Bellis et al., 1999), attenuation of frontal lobe symmetry (Carrion et al.), and prefrontal cortical dysfunction (De Bellis, Keshavan, Spencer, & Hall, 2000; De Bellis et al., 2002) in childhood PTSD. Whereas PTSD in adults has been associated with smaller hippocampal volume in a number of studies (Bremner, Randall, Vermetten, & Staib, 1997; Bremner et al., 1995; Gilbertson et al., 2002; Gurvitz, Shenton, Hokama, & Ohta, 1996; Pavic et al., 2007; Stein et al., 1997; Villarreal et al., 2002; Wannill et al., 2004), studies of children have been somewhat mixed, but generally childhood PTSD has not been found to be associated with expected decreases in hippocampal volume in cross-sectional (Carrion et al., 2001; De Bellis et al., 1999; De Bellis et al., 2002) or longitudinal studies (De Bellis, Hall, Boring, Frustaci, & Moritz, 2001). In fact, there is some evidence that hippocampal volumes are larger in children with PTSD (Tupler & De Bellis, 2006). In contrast to these findings, in a recent longitudinal study of children with a history of maltreatment, Carrion, Weems, and Reiss (2007) hypothesized that hippocampal volume reductions may result from chronic exposure to stress throughout development and found that PTSD symptoms and cortisol levels predicted hippocampal reduction over a 12- to 18-month interval. This result offers tentative support for the notion that hippocampal alterations may also be evident in childhood PTSD and these alterations may change over time.

To date, few studies have examined neuropsychological functioning in children with PTSD. Beers and De Bellis (2002) examined 14 children with maltreatment-related PTSD (physical or sexual abuse, or witnessing of intimate partner violence) and 15 healthy socio-demographically comparable children. Participants were primarily Caucasian and of middle-class socioeconomic status, and mean IQ was in the average to above average range. They found that children with maltreatment-related PTSD demonstrated significant deficits within the domains of attention and executive function (as measured by the Stroop Color-Word Association Test, the Digit Vigilance Test, the Wisconsin Card Sorting Test, and the Controlled Oral Word Association Test) when compared to the healthy children who had not been maltreated. The children with PTSD demonstrated greater impulsivity and distractibility and made more errors on a task of sustained attention. Contrary to adult findings of memory problems associated with PTSD, but consistent with neuroimaging findings failing to find hippocampal alterations in childhood PTSD (Carrion et al., 2001; De Bellis et al., 1999; De Bellis et al., 2002), the children with PTSD did not demonstrate memory impairments, as measured by the California Verbal Learning Test – Children’s Version (CVLT-C; Delis, Kramer, Kaplan, & Ober, 1994). The authors attributed this lack of finding in part to the small sample size. Because this study lacked a comparison group of children who had been maltreated but did not have PTSD, the authors cautioned that their findings of executive
functioning and attention deficits may be related to trauma exposure rather than to the presence of PTSD. Similarly, Moradi, Doost, Taghavi, Yule, & Dagleish, (1999) examined everyday memory performance in children with PTSD from motor vehicle accidents compared to trauma-unexposed controls. Children with PTSD performed more poorly on tasks from the Rivermead Behavioural Memory Test (Wilson, Cockburn, & Baddeley, 1986), a measure designed to test memory skills related to everyday situations, such as remembering appointments, names, and faces.

Yasik, Saigh, Oberfield, and Halamandaris (2007) compared children with PTSD to a group of trauma-exposed children without PTSD and a nontraumatized control group on the Wide Range Assessment of Memory and Learning (WRAML; Sheslow & Adams, 1990). The trauma-exposed children had experienced a wide range of traumas, including physical and sexual assault and accidents; although children with a history of child abuse and neglect perpetrated by a parent were excluded. The children with PTSD evidenced lower scores on verbal memory tasks compared to the trauma-exposed children without PTSD, and they had general memory and learning deficits compared to the nontraumatized group. The trauma-exposed children without PTSD did not significantly differ from the nontraumatized group on any memory or learning tasks. The study’s design allowed the researchers to disentangle effects of PTSD from effects of trauma exposure; however, the three groups were not equivalent on a number of background variables, including gender, ethnicity, socioeconomic status (SES), and trauma history, and these variables were not statistically controlled for in analyses. In addition, IQ scores were not reported. As IQ is moderately correlated with WRAML performance (Sheslow & Adams), if IQ differences exist between the groups, it is unclear if observed memory deficits may in fact be due to lower cognitive ability, rather than PTSD. The researchers excluded participants with comorbid psychiatric conditions, allowing for a more straightforward interpretation of results being attributable to PTSD. However, because PTSD is often comorbid with other conditions, the exclusion of individuals with these conditions threatens the generalizability of findings to a real world clinical population of children with PTSD.

Inconsistencies in research findings on the neuropsychological functioning of childhood PTSD may be due to small sample sizes or lack of trauma-exposed control groups (Beers & De Bellis, 2002) or demographically dissimilar comparison groups (Yasik et al., 2007). The question arises as to whether executive functioning, attention, and memory deficits exist in childhood PTSD, and, if so, whether such deficits are attributable to PTSD or to trauma exposure. A further question concerns the extent to which such cognitive functioning deficits are attributable to confounding variables, such as IQ, comorbid psychiatric conditions, ethnicity, or socioeconomic status. The present study attempts to address these questions by comparing two demographically similar groups of children with similar trauma histories — children with PTSD related to witnessing IPV, and children who have witnessed IPV but do not have PTSD. It was hypothesized that children with PTSD would show poorer performance on tasks of executive functioning, working memory, attention, and verbal memory and learning.

METHODS

Participants

Participants were recruited from the community, but not from shelters as added stressors in the shelter environment can impact children’s psychological adjustment. Flyers for the study were posted in the community (e.g., YMCAs, bus stations, colleges,
housing projects), at community and mental health agencies, and through an advertisement on an online community message board.

**Inclusion criteria.** Children with current full or partial PTSD (defined as meeting diagnostic criteria for Cluster B and either Cluster C or Cluster D; Blanchard, Hickling, Taylor, Loos, & Gerardi, 1994) on the Clinician Administered PTSD Scale – Children and Adolescent Version (CAPS-CA; Nader et al., 1996) were included in the PTSD+ group. Children with no current, partial, or lifetime history of PTSD were included in the PTSD− group. Carrion, Weems, Ray, and Reiss (2002), in their study investigating the phenomenology of childhood PTSD, note that “there is little empirical evidence that the tripartite clustering of symptoms that depict adult PTSD appropriately characterizes pediatric PTSD” (p. 167) and demonstrated in their sample that children with partial PTSD did not differ from children with full PTSD with regards to functional impairment and distress. The event assessed for all children was witnessing IPV.

**Exclusion criteria.** Exclusion criteria included major birth complications; head injury associated with loss of consciousness; history of seizure disorders, or any other substantial medical illness that could affect the central nervous system; and developmental delays resulting in placement in special education classrooms (e.g., pervasive development disorders, mental retardation). In addition, children who were currently being treated with psychotropic medications were excluded. Children without current PTSD, but with a lifetime history of PTSD, as assessed by structured interview, were excluded. Children with PTSD to an event other than IPV were also excluded, in an effort to preserve the homogeneity of the sample. Finally, children with histories of psychotic disorder or bipolar disorder, or adolescent-onset alcohol or substance abuse or dependence, as assessed by structured interview, were excluded from data analysis.

Seventy-four children who had witnessed IPV between their mothers and a partner participated in the study. Twelve of these participants were excluded following the interview for the following reasons: inability to report symptoms (n = 3), comorbid diagnoses of alcohol abuse or dependence (n = 2), diagnosis of drug abuse (n = 1), psychotic symptoms (n = 1), receiving special education services for mental retardation (n = 2), PTSD to an event other than IPV (n = 1), and lifetime but not current diagnoses of PTSD (n = 2).

**Background characteristics.** The final sample (n = 62) included 27 children in the PTSD+ group with diagnoses of full (n = 18) or partial (n = 9) PTSD due to exposure to IPV, and 35 children without PTSD (i.e., PTSD−). The participants were ethnically diverse, although predominantly African American (73%). English was the dominant language for all participants. The mean income for the sample was $26,126 (SD = $21,478).

**Procedures**

The protocol and all consent forms were approved by Alliant International University’s Institutional Review Board. Mothers were interviewed about their experiences of IPV and their children’s experiences witnessing IPV and were administered an interview about the psychological functioning of their children. Children completed neuropsychological tests and then were administered structured interviews to assess mental health diagnoses and PTSD status. Participation took three to four hours and testing was completed over one to two visits, depending on the age of the child. Families were
compensated for their participation and received referrals to various local agencies for follow-up support.

Due to the sensitive nature of the interview questions, informed consent included a statement that if it were revealed during the interview that the child had been harmed, the interviewer would contact appropriate authorities. Nine reports were made to Child Protective Services based on maternal or child reports of abuse or neglect. Because families were informed of the necessity to report child abuse, data on child maltreatment may underrepresent the actual prevalence in this sample.

**Measures**

The mother was administered the following instruments.

**Background information questionnaire.** Mothers were asked to provide background data about her child, such as age, ethnicity, level of education, and history of mental health interventions. Questions about the child’s health and trauma history were also asked.

**Conflict Tactics Scale 2 (CTS2).** The Conflict Tactics Scale (Straus, 1979; Straus, Hamby, Boney-McCoy, & Sugarman, 1996) is a self-report questionnaire that assesses the occurrence and the frequency of particular behaviors during interpersonal conflicts. The Revised Conflict Tactics Scale (CTS2) has five subscales: Negotiation, Psychological Aggression, Physical Assault, Sexual Coercion, and Injury. The CTS2 was administered as an interview. Mothers were asked to answer questions about her batterer’s behaviors towards her, and her child’s experience of witnessing those behaviors. Scores from this measure were used to determine the frequency and severity of IPV.

**The Schedule for Affective Disorders and Schizophrenia for School-Age Children (K-SADS-PL).** The K-SADS-PL (Kaufman et al., 1997) is a semi-structured diagnostic interview administered to both mother and child, designed to assess current and past episodes of psychopathology in children and adolescents according to Diagnostic and Statistical Manual of Mental Disorders, fourth edition (DSM-IV; American Psychiatric Association, 1994) criteria. The child’s scores were compared with the mother’s scores in order to determine the final rating. The child and mother interviewers discussed discrepancies in diagnoses endorsed by mother and child and then determined what was agreed to be the most valid rating, as advised in the K-SADS-PL manual (Kaufman et al.). The children were assessed for mood disorders, psychotic disorders, anxiety disorders, behavioral disorders, and substance use disorders. In order to ensure that participants did not have any of the exclusion criteria, they were assessed for the following past diagnoses: bipolar disorders, psychotic disorders, and alcohol and substance abuse or dependence. Three mother-child dyads had discrepant reports for depression or dysthymia diagnoses. In all three cases, the child endorsed symptoms meeting diagnostic criteria, and the mother denied symptoms. All three of these cases were coded as positive for depressive disorder, as research suggests that children are more accurate reporters of internalizing symptoms than parents, given that these subjective symptoms are not easily observed by parents (Andrews, Garrison, Jackson, Addy, & McKeown, 1993; Herjanic & Reich, 1997; Karver, 2006). Two mother-child dyads had discrepant reports for overanxious disorder symptoms, with mothers endorsing symptomatology that children denied. We did not code...
these cases as positive for overanxious disorder, because we felt the child’s report of internalizing symptoms to be more accurate. Two mother-child dyads had discrepant reports for attention deficit/hyperactivity disorder (ADHD); in both cases the mother reported symptoms that the child denied. We coded both of these cases as positive for ADHD, as research has suggested that parents are more likely to accurately report externalizing behaviors, particularly those symptoms that affect school functioning: not only are children less likely to find the negative consequences of these behaviors troublesome and therefore salient in a diagnostic interview but teachers may convey their concern about these symptoms more clearly to parents than to children (Herjanic & Reich).

In addition to the K-SADS-PL, the children were administered the following instruments.

**Clinician-Administered PTSD Scale for Children (CAPS-CA).** The Child and Adolescent version of the CAPS-CA (Nader et al., 1996) is a structured clinical interview intended for children aged 7 and above that assesses the 17 symptoms for posttraumatic stress disorder (PTSD) outlined in DSM-IV. The Life Events Checklist (LEC), a measure of exposure to potentially traumatic events, is part of the introduction to the CAPS-CA. The LEC identifies possible Criterion A events that the participants may have been exposed to in their lifetime. A full diagnosis of PTSD was given if a child experienced one or more Cluster B symptoms (re-experiencing), three or more symptoms in Cluster C (avoidance), and two or more symptoms in Cluster D (hyperarousal). A diagnosis of partial PTSD was given if a child experienced the required number of symptoms of Cluster B and either Cluster C or Cluster D.

**Neuropsychological measures**

**IQ.** An IQ estimate was derived from utilizing Sattler’s (1992) prorating method using scores on three subtests of the Wechsler Intelligence Scale for Children – Fourth Edition (Wechsler, 2003) — Vocabulary, Information, and Block Design.

**Verbal memory.** To assess verbal memory and learning, we used six variables from the California Verbal Learning Test – Children’s Version (CVLT-C; Delis et al., 1994). The CVLT-C measures both recall and recognition of word lists over a number of trials. The Trial 1 score provides a measure of attention and initial acquisition of verbally presented material, whereas the Trial 5 score and the total score of Trials 1–5 provide measures of verbal learning. A second list, List B, is introduced as an interference measure, and scores on that variable assess the ability to attend to and acquire new words while minimizing the interference of the prior list. Following List B, the child is asked to recite the original word list, a measure of Short-Delay Free Recall (SDFR). Finally, 20 minutes later the child is asked to remember as many of the words as he or she can, a measure of Long-Delay Free Recall (LDFR).

**Executive functioning.** Executive functioning is a multifaceted construct and this study utilizes three measures commonly used in research to measure the facets of inhibition, set shifting, planning and problem-solving abilities. Two of these measures — the Wisconsin Card Sorting Test (Heaton, 1981) and Stroop Color-Word Association Test (Stroop, 1935; Golden, 1978) — were found to differentiate children with and without PTSD in previous research (Beers & De Bellis, 2002).
The *Wisconsin Card Sorting Test* – *64 card version* (WCST; Heaton, 1981) assesses executive functions; specifically, the ability to shift set, to monitor, and to use feedback. The test consists of a deck of 64 response cards that vary according to color, geometric shape, and number. The child is given four stimulus cards and then asked to sort the remaining deck of cards using feedback provided by the examiner. Following 10 correct sorts on a given category, the examiner switches to another category without informing the child of the switch. The child’s performance is scored on the total number of categories achieved, perseverative errors, and total errors.

The *Tower of London* (Shallice, 1982) assesses higher level problem-solving abilities, working memory, response inhibition, and visual spatial memory. In this task the child must plan ahead to determine the order of moves necessary to rearrange three colored rings or balls from their initial position on two of three sticks to a new set of predetermined positions on one or more sticks. The child’s performance is scored on total items correct, total moves, and total rule violations (e.g., moving two balls at once). The *Stroop Color-Word Association Test* (Golden, 1978; Stroop, 1935) evaluates sustained and selective attention as well as freedom from distractibility and inhibitory control. It is composed of three cards containing five columns of 20 items. The child is asked to read (as rapidly as possible) a list of color names (blue, red, and green) in black ink, name colored patches of ink, and finally to name the dissonant color of ink in which a word is printed. This third portion, the color-word portion of the test, was of interest.

Attention, working memory, and processing speed. Working memory and attention were assessed with the Letter Number Sequencing and Digit Span subtests of the WISC-IV. During the Letter Number Sequencing subtest, a measure of auditory working memory, the child is read a series of numbers and letters and is asked to repeat them, saying the numbers first in ascending order and then the letters in alphabetical order. The Digit Span subtest requires the participant to repeat a series of digits in the same sequence as the examiner presented, both forwards and backwards. To assess processing speed, the Digit Symbol-Coding subtest of the WISC-IV was administered. The child is presented with a key of numbers corresponding with symbols and is required to use the key to copy the symbols under the numbers.

Data Analysis

PTSD+ and PTSD− groups were compared on background characteristics, trauma history variables, IQ estimate, and comorbid diagnoses using *t*-tests or chi-square tests of association, depending on variable type. As many of these variables are considered risk factors in the development of PTSD (e.g., gender, ethnicity, income, abuse history) or would be expected to be lower (e.g., IQ) or at higher rates (e.g., comorbid diagnoses, history of mental health treatment) in the PTSD+ group, one-tailed *t*-tests were conducted to determine if the two groups were significantly different. Potential confounds were included as covariates in subsequent analyses. The groups were compared on measures of verbal memory, executive functioning and attention, working memory, and processing speed using multivariate analysis of covariance omnibus tests of significance to protect against inflation of Type I error. When significant results were obtained through the omnibus MANCOVA tests, individual ANCOVA tests were conducted to further examine differences between groups.
RESULTS

Background characteristics, clinical and trauma history variables, and estimated IQ are summarized in Table 1. The groups did not differ by age, gender, income, ethnicity, or education. Both groups’ estimated IQ scores were in the low average range, and there was a nonsignificant trend \( (p = .07) \) for lower performance by the PTSD+ group.

As expected, the PTSD+ group had higher CAPS-CA scores than the PTSD− group. Information about comorbid mood and anxiety disorder diagnoses is also included in Table 1. There were no significant differences between the PTSD+ and PTSD− groups in rates of mood disorders (major depressive disorder and dysthymia), anxiety disorders, or ADHD.

Mothers reported on the amount of physical violence the children witnessed between mothers and an intimate partner. The two groups were comparable, with both groups witnessing a great deal of IPV in the last year of their mothers’ partner relationship. Ten of the children with PTSD, and 7 of the children without PTSD had also experienced physical or sexual abuse or neglect, which resulted in a nonsignificant trend difference between groups \( (p = .08) \). Fifty-eight percent had received mental health services at some point in their lives, and there were no significant differences between the two groups.

Although there were no significant differences between the groups on any demographic and clinical characteristics, there were two nonsignificant trend findings of lower IQ scores and higher rates of abuse histories in the PTSD+ group. These variables were examined in relation to the neuropsychological test variables to further determine if they might represent confounds and should be included as covariates in subsequent analyses. IQ was significantly correlated with all of the neuropsychological test variables (Pearson \( r \)s ranging from .25 to .55) except for Towers Total Correct \( (r = .099, p = .45) \) and Towers.

<table>
<thead>
<tr>
<th>Demographic Variables</th>
<th>PTSD+ ((N = 27))</th>
<th>PTSD− ((N = 35))</th>
<th>Statistic</th>
<th>(p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>12.1 (3.0)</td>
<td>11.4 (2.6)</td>
<td>(t = -1.06)</td>
<td>.15</td>
</tr>
<tr>
<td>Education (grade)</td>
<td>6.4 (3.0)</td>
<td>6.0 (2.5)</td>
<td>(t = -0.62)</td>
<td>.27</td>
</tr>
<tr>
<td>Gender</td>
<td>68% male</td>
<td>49% male</td>
<td>(\chi^2 = 0.30)</td>
<td>.31</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>81% African American</td>
<td>66% African American</td>
<td>(\chi^2 = 5.58)</td>
<td>.12</td>
</tr>
<tr>
<td>BMI</td>
<td>28.5 (4.9)</td>
<td>28.9 (4.9)</td>
<td>(t = -0.07)</td>
<td>.70</td>
</tr>
<tr>
<td>Mother’s education level</td>
<td>12.9 (1.7)</td>
<td>13.0 (2.0)</td>
<td>(t = 0.16)</td>
<td>.44</td>
</tr>
<tr>
<td>Estimated IQ</td>
<td>84.9 (12.9)</td>
<td>89.9 (13.5)</td>
<td>(t = 1.50)</td>
<td>.07</td>
</tr>
<tr>
<td>History of abuse</td>
<td>37%</td>
<td>20%</td>
<td>(\chi^2 = 2.22)</td>
<td>.08</td>
</tr>
<tr>
<td># of IPV events witnessed in a year</td>
<td>43.1 (62.6)</td>
<td>55.9 (62.1)</td>
<td>(t = 0.743)</td>
<td>.33</td>
</tr>
<tr>
<td>History of mental health treatment</td>
<td>63%</td>
<td>54%</td>
<td>(\chi^2 = 0.471)</td>
<td>.43</td>
</tr>
<tr>
<td>Other diagnoses</td>
<td>4 Mood</td>
<td>2 Mood</td>
<td>(\chi^2 = 1.32)</td>
<td>.12</td>
</tr>
<tr>
<td></td>
<td>0 Overanxious</td>
<td>1 Overanxious</td>
<td>(\chi^2 = 0.78)</td>
<td>.27</td>
</tr>
<tr>
<td></td>
<td>4 ADHD</td>
<td>6 ADHD</td>
<td>(\chi^2 = 0.06)</td>
<td>.40</td>
</tr>
<tr>
<td>CAPS-CA score</td>
<td>39.7 (11.1)</td>
<td>9.6 (9.1)</td>
<td>(t = -10.79)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Note. CAPS-CA = Clinician Administered PTSD Scale, Child and Adolescent Version. All tests were one-tailed.

Mood = diagnoses of Major Depressive Disorder or Dysthymia.
Total Moves ($r = .118$, $p = .366$). Thus, IQ was entered as a covariate in all subsequent analyses. The $t$-tests were conducted to examine if there were significant differences on neuropsychological test performance between children with and without abuse histories, and none were found. Thus, abuse history was not entered as a covariate in subsequent analyses.

Table 2 presents means and standard deviations for all of the neuropsychological variables by group. We conducted a MANCOVA using four variables of the CVLT-C as dependent variables: Total Trials 1–5, List B, SDFR, and LDFR. There was an overall significant effect for PTSD on verbal memory and learning after controlling for IQ, $F(4, 56) = 4.47$, $p = .003$, partial eta$^2 = .24$. Post-hoc ANCOVAs showed differences between the groups on Total Trials 1–5, $F(1, 60) = 12.58$, $p < .001$, List B, $F(1, 60) = 6.01$, $p = .016$, and LDFR, $F(1, 60) = 5.60$, $p = .02$, but not for SDFR, $F(1, 60) = 3.09$, $p = .084$. We also examined Trial 1 and Trial 5 scores separately using analyses of covariance, which revealed a significant difference between groups on Trial 5 score, $F(1, 60) = 8.80$, $p = .004$, when controlling for IQ. There was not a significant difference between groups on Trail 1 after controlling for IQ, $F(1, 60) = 2.11$, $p = .151$. Since performance on short and long delayed recall is dependent on amount of information learned on total learning (Total Score Trials 1–5), differences on LDFR were analyzed with an analysis of covariance, controlling for total learning. When controlling for Total Score Trials 1–5, there was no longer a significant difference between the groups on Long Delay Free Recall, $F(1, 60) = 0.992$, $p = .323$. Because total learning is dependent on initial attention, an ANCOVA was
conducted using Trial 1 performance as a covariate. The group difference on Total Trials 1–5 persisted when controlling for initial attention, $F(1, 60) = 12.3, p = .001$.

The MANCOVA analyzing group differences on the seven executive functioning variables, controlling for IQ, did not produce significant findings, $F(7, 48) = 0.852, p = .551$. The two groups were also not significantly different on tests of attention, working memory, and processing speed, $F(3, 57) = 0.787, p = .506$.

To further ensure that children with partial PTSD were significantly different from the children without PTSD, and similar to children with full PTSD as their data was combined into one group, a series of $t$-tests were conducted comparing the three groups (full PTSD, partial PTSD, and PTSD−) on all outcome measures. There were significant differences between the PTSD− and partial PTSD groups on CVLT-C Total Score ($p = .001$) and List B ($p = .01$). There were no significant differences between the PTSD− group and the partial PTSD group on any of the executive functioning and attention measures. There were no significant differences between the full PTSD and partial PTSD groups on any variables (all $p > .15$); although group sizes may be too small to detect a significant difference. Means, standard deviations, and skewness statistics appeared similar for the two groups on all neuropsychological variables and did not suggest that the children with partial PTSD represent an intermediate group whose neuropsychological functioning lies in between that of the children with and without full PTSD.

**DISCUSSION**

The purpose of the present study was to determine whether executive functioning, attention, and memory deficits exist in childhood PTSD, and, if so, whether such deficits are attributable to PTSD or to trauma exposure. By comparing children with PTSD due to witnessing IPV to a trauma-exposed control group also exposed to IPV, findings of neuropsychological deficits could more likely be ascribed to PTSD. Children with full or partial PTSD due to witnessing IPV demonstrated significant verbal memory deficits when compared with IPV-exposed, sociodemographically similar children without PTSD. The children with PTSD showed slower and less effective learning, showed heightened sensitivity to interference and demonstrated an impaired effect of rehearsal on memory acquisition on the CVLT-C, a word list learning task. When controlling for initial learning of words, children with PTSD did not demonstrate impaired short and long delay recall, suggesting that memory problems in PTSD are related to learning but not to retrieval. This performance pattern is consistent with adult studies of PTSD (Johnsen, Kanagaratnam, & Asbjornesen, 2008; Samuelson et al., 2006; Vasterling et al., 1998) and is suggestive of disturbed frontal lobe functions, but not medial temporal involvement (Vasterling et al.). Thus, this pattern of findings may be consistent with neuroimaging studies demonstrating prefrontal cortical dysfunction in childhood PTSD (De Bellis et al., 2000; De Bellis et al., 2002). Children with PTSD did not demonstrate impaired performance on initial acquisition of words, as measured by Trial 1 score of the CVLT-C. This finding, also consistent with some adult studies of PTSD (Johnsen et al.; Yehuda, Golier, Tischler, Stavitsky, & Harvey, 2005), suggests that children with PTSD do not struggle with initial attention to new material but instead struggle with learning and immediate recall of the material over subsequent trials.

The findings of impaired learning paired with lack of forgetting is particularly interesting in the context of PTSD, where sufferers may not be able to organize or express a cohesive narrative of their traumatic event but rather reexperience the event through
intrusions, nightmares, or flashbacks. Whether the verbal learning deficits are an outcome of PTSD or a preexisting risk factor cannot be answered within this study’s cross-sectional design. There is some evidence with adults that verbal memory deficits serve as a vulnerability factor in the development of PTSD (Gilbertson et al., 2006). Preexisting verbal learning deficits may cause the difficulty in organization of a cohesive narrative; the difficulty with putting a traumatic event into words and assigning meaning to it may intensify the event’s adverse emotional impact. Alternatively, PTSD may result in increased arousal and secretion of cortisol, which interferes with one’s ability to attend to and learn new information. Prospective studies are needed to determine whether preexisting deficits in learning increase one’s vulnerability to developing PTSD or whether PTSD itself interferes with one’s ability to learn new information adequately.

Our results are consistent with findings of Yasik et al. (2007) documenting verbal memory deficits in children with PTSD compared to trauma-exposed children without PTSD. With the exception of a trend towards lower IQ and increased exposure to child abuse in the children with PTSD, the groups were equivalent across demographic variables and comorbid psychiatric conditions, strengthening the conclusion that observed differences are related to PTSD. The trend findings are consistent with previous research that has found a significant association between PTSD and lower scores on measures of verbal IQ in children (Saigh, Yasik, Oberfield, Halamandaris, & Bremner, 2006; Saltzman, Weems, & Carrion, 2006), as well as a meta-analysis of adults documenting an association between higher levels of PTSD symptoms and increased trauma exposure (Brewin, Andrews, & Valentine, 2000). Again, it is unclear whether lower IQ represents a premorbid risk factor for PTSD (Macklin et al., 1998).

Contrary to hypotheses, differences were not found between children with and without PTSD on tasks of executive functioning, attention, working memory, and processing speed. These results are not consistent with findings of Beers and De Bellis (2002); however, a notable distinction is the lack of a trauma-exposed control group in that study. It may be that executive functioning and attention deficits observed in their sample are due to exposure to IPV, and not due to PTSD. Children in the control group in Beers and De Bellis’ study performed in the average range on tests of executive functioning and attention, with the children with PTSD demonstrating below average performance. In the current study, scores were primarily in the below average range for both groups, which is consistent with the hypothesis that executive functioning and attention deficits are due to exposure to violence, regardless of whether PTSD develops or not. Alternatively, the lowered executive functioning performance may be due to the low socioeconomic status (Noble, Norman, & Farah, 2005) or low average IQ of the sample. Future research might include a third, trauma-unexposed, sociodemographically similar control group to tease apart the contributions of trauma exposure and PTSD to neuropsychological functioning. Furthermore, measures of executive functioning used in the current study were selected based on their ability to differentiate between children with PTSD and normal controls in previous research and were not specifically developed for children. Future research should use measures more sensitive to executive dysfunction in this age group to better assess this construct.

It is noteworthy that our sample consisted of primarily African American children living in low-income families, and results may not be generalizable to more diverse samples, or in samples of children with PTSD to different traumas. Nevertheless, this is also a strength of the study because it is characteristic of children at relatively greater risk of PTSD, as family violence is more prevalent in disadvantaged communities (Benson, Fox,
DeMaris, & Van Wyk, 2003). Another notable finding is the relatively low rate of comorbid Axis I disorders reported and the lack of difference between the two groups on rates of diagnoses. One possible explanation may lie in the design of the K-SADS-PL, which was used to diagnose exclusionary and comorbid diagnoses. The main module, administered to all participants, consists of questions that screen for some, but not all, symptoms of the various Axis I disorders. Only if these symptoms are endorsed does the interviewer then complete a supplemental portion of the interview, which asks about the remaining symptoms of each disorder. It is possible that in some cases, a child or mother would have endorsed enough symptoms in the supplemental portion to meet diagnosis but was not administered these items due to a lack of endorsement of the screener items for the disorder. Further studies might utilize additional measures of mental health diagnoses that are often comorbid in PTSD, such as the Children’s Depression Inventory (Kovacs, 1992). An additional limitation of the study is our failure to examine visual memory performance. Although impaired visual memory performance has not been demonstrated in two prior studies of neuropsychological functioning in childhood PTSD (Beers & De Bellis, 2002; Yasik et al., 2007), nor in a meta-analysis of adult PTSD neuropsychological studies (Brewin, Kleiner, Vasterling, & Field, 2007), a more thorough examination of neuropsychological deficits in childhood PTSD warrants inclusion of visual memory measures.

Further neurocognitive and neuroimaging studies of childhood PTSD are needed, utilizing larger sample sizes and demographically similar, trauma-exposed control groups. Future studies are needed to distinguish the unique contribution of comorbid disorders, particularly depression, from that of PTSD and trauma exposure to the neuropsychological functioning of children. Researchers should also attempt to replicate findings in samples of children with other types of trauma exposure, and with younger children. Finally, longitudinal studies are warranted to best understand the pathways from trauma exposure to biological changes and neurocognitive deficits.

REFERENCES


