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Neuropsychological Findings in Childhood Neglect and their Relationships to Pediatric PTSD

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Abstract

Statement of the problem—Although child neglect is the most prevalent form of child maltreatment, the neurocognitive effects of neglect is understudied.

Methods—We examined IQ, reading, mathematics, and neurocognitive domains of fine-motor skills, language, visual-spatial, memory/learning, and attention/executive functions in two groups of non-sexually abused medically healthy neglected children, one with DSM-IV posttraumatic stress disorder (PTSD) and one without, and a demographically similar healthy non-maltreated control group.

Key findings—Significantly lower IQ, reading, mathematics, and selected differences in complex visual attention, visual memory, language, verbal memory and learning, planning, problem solving, and speeded naming were seen in Neglect Groups. The Neglect with PTSD Group performed worse than controls on NEPSY Design Copying, NEPSY Tower, and Mathematics; and performed worse than controls and Neglect without PTSD on NEPSY Memory for Faces-Delayed. Negative correlations were seen between PTSD symptoms, PTSD severity, and maltreatment variables, and IQ, Academic Achievement, and neurocognitive domains.

Conclusions—Neglected children demonstrated significantly lower neurocognitive outcomes and academic achievement than controls. Lower IQ, neurocognitive functions, and achievement may be associated with more PTSD symptoms (particularly re-experiencing symptoms), greater PTSD severity, and a greater number of maltreatment experiences. Trauma experiences may additionally contribute to subsequent neurodevelopmental risk in neglected children.

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All of the authors have no conflict of interest affecting this study.

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Mesh Terms

Neurocognitive functioning in maltreatment; childhood maltreatment; cognitive functioning in neglect; academic achievement; attention, memory; IQ; executive function; neuropsychological tests

Introduction

Although child neglect is the most prevalent form of child maltreatment, research on the neurocognitive effects of maltreatment has focused on physical and sexual abuse. The core feature of child neglect is a chronically impoverished parent-child relationship (Scannapieco, 2008). The relationship between a consistent caregiver and infant is an essential experience-dependent interaction for normal development. Preclinical studies of early privation and investigations of atypical rearing situations with humans suggest that the absence of a reliable and consistent caregiver for a young child is associated with a negative impact on the developing brain which, in turn, has effects on the adult brain (De Bellis, 2005) and overall function (McGloin & Widom, 2001). The seminal studies of Harlow and colleagues suggested that the nature, age of onset, duration of neglect, and the availability of an enriched environment during primate infancy were important contributors to becoming an "isolate" versus a normal functioning adult primate (Harlow et al., 1971). In prospective studies, child neglect has been associated with significantly lower intellectual development in young children who were recruited for low birth weight (1000 gms) (Strathearn et al., 2001) and with persistent effects of lower IQ and academic achievement in adulthood (Perez & Widom, 1994).

Neglect may be experienced by a child, a member of a social species, as traumatic, causing anxiety and leading to adverse brain development (De Bellis, 2005). Neglect may be co-morbid with witnessing family violence. In the National Survey of Child and Adolescent Well-Being, the first nationally representative study of children referred to the child welfare system (Burns et al., 2004), high rates of domestic violence were reported (Hazen et al., 2004). In a twin study of 1116 families of monozygotic and dizygotic 5 year old twin pairs, children exposed to high levels of domestic violence had IQs that were on average 8 points lower than unexposed children (Koenen et al., 2003). These subjects were not assessed for posttraumatic stress disorder (PTSD). IQ was negatively associated with number of traumas and PTSD re-experiencing symptoms in children who experienced interpersonal violence (Saltzman et al., 2006). Family violence and PTSD symptoms may also contribute to lower IQ and cognitive deficits in neglected children.

The developing brain areas most vulnerable to early stress include the prefrontal cortex, hippocampus, and corpus callosum (Teicher et al., 1997). These structures are influenced by the biological stress systems (De Bellis, 2001). The stress response involves secretion of many neurotransmitters (e.g., norepinephrine and dopamine). During prolonged stress, dopamine and norepinephrine levels are raised, possibly leading to prefrontal cortex dysfunction (A. F. T. Arnsten, 1998; A. F. T. Arnsten & Goldman-Rakic, 1998), and then to symptoms of inattention, impairment in executive functions, and new learning and memory.

Traumatic events are common in the lives of children (Copeland et al., 2007). The diagnosis of PTSD is defined as the development of characteristic symptoms after a person experiences a life-threatening traumatic event (referred to as a Type A trauma), such as child abuse or witnessing family violence; and reacts with fear or disorganized behavior, followed by three categorical of symptom clusters for at least one month: Cluster B - intrusive re-experiencing of the trauma(s); Cluster C - persistent avoidance of stimuli associated with the

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trauma(s) or numbing of responsiveness; and Cluster D - persistent symptoms of increased physiological arousal (American Psychiatric Association, 2000).

Neglect is defined as failure to provide for or supervise one's child. In a young child, caregiver neglect can be life threatening. Stress in children with or without a diagnosis of PTSD may affect selective attention, hindering their ability to remember and to discriminate between relevant and irrelevant information (Lupien et al., 2005). Neglect commonly co-occurs with physical or sexual abuse (J. Kaufman et al., 1994), traumatic events that may lead to PTSD. Pediatric maltreatment-related PTSD is associated with adverse brain development (De Bellis et al., 2002). Neurocognitive deficits reflecting these stress-sensitive brain regions include intelligence and academic achievement, and specific measures of executive function, language, memory, and learning. Abused children with DSM-IV defined PTSD showed poorer attention and executive function during a comprehensive neurocognitive assessment than non-abused controls (Beers & De Bellis, 2002). Neglected children and adults with neglect histories demonstrated lower IQ, delays in academic achievement and neurocognitive function, antisocial behaviors, and impairing psychopathology (Eckenrode et al., 1993; Kolko, 1992; McGloin & Widom, 2001; Perez & Widom, 1994; Widom et al., 2007). However, there are no published studies comprehensively examining specific neurocognitive domains in neglected children.

The primary purpose of this study was to examine neurocognitive functions in neglected children. Given that neglected children are more likely to witness domestic violence and have other traumas, we assessed subjects for a variety of DSM-IV Type A traumas and PTSD. We hypothesized that neurocognitive problems may be seen in neglected children due to the traumatic experience of neglect (e.g. failures to provide or supervise) and to traumatic experiences (e.g., physical abuse, emotional abuse, and witnessing violence)(Levy et al., 1995), resulting in PTSD symptoms. In this investigation, we examined IQ, fine-motor skills, language, visual-spatial, memory/learning, attention/executive functions, and academic achievement in non-sexually abused medically healthy children with a history of neglect, with and without PTSD, and a demographically matched group of non-neglected children. We hypothesized that children with neglect would perform less well on standardized neurocognitive tests and academic achievement than controls, and that those with neglect and PTSD would show the poorest performance. We further explored the inter-relationships between PTSD and maltreatment measures, and neuropsychological functioning for our PTSD subsample, hypothesizing that the greater the PTSD symptomotology and number of maltreatment experiences, the lower the neurocognitive performance.

Methods

Participants

Participants were: Neglect with PTSD (n = 22), Neglect without PTSD (n = 39), and Controls (n = 45). Neglect was defined as a child having a history of Department of Social Services (DSS) defined neglect with absence of sexual abuse. The Neglect Groups were recruited through advertisements targeted at DSS agencies. The groups were similar on age, gender, race, and Hollingshead Index of socioeconomic strata (SES). Controls were recruited from the same surrounding community through IRB approved advertisement at schools and pediatric clinics. Participants statewide were eligible. To reduce selection biases, participants who lived greater than 75 miles from the Research Program were given overnight accommodations. Exclusion criteria were: 1) FS IQ < 70; 2) disability that made a comprehensive interview of the child difficult; 3) significant medical illness, head injury, or neurological disorder; 4) autism or pervasive developmental disorder; and 5) birth weight under 5 lbs or severe prenatal compromise with NICU stay. The groups were significantly

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different on caregiver IQ, with the Neglect Groups performing at a lower level than Controls. Given the low number of children in the neglect group who were living with their biological parents, caregiver IQ was not covaried in the data analyses. See Table-1. The local university hospital IRB committee approved the study. Legal guardians gave informed consent and children assented prior to participation.

Neuropsychological Measures

The battery was selected *a priori* to assess the functions of fine-motor, language, visual-spatial processing, memory/learning, attention/executive functions, and reading and mathematics achievement. The battery was age-appropriate, psychometrically sound, and driven by core hypotheses. Given the limited research in this area, the battery was designed to broadly examine cognitive function.

NEPSY (Korkman et al., 2001). A child neuropsychological battery that consists of 36 psychometrically developed subtests designed for children ages 3–12. The core battery consists of 14 subtests that measure language, fine-motor, visual-spatial, memory/learning, and attention/executive functions. Scales produce an age-based scaled score (mean of 10 and standard deviation of 3). Participants were administered the core 14 subtests plus Block Construction. We included age-based scaled scores for the supplementary tasks for Auditory Attention (Auditory Attention Task, Response Set Task), Memory for Faces (Immediate, Delay), and Memory for Names (Learning Trials, Delayed).

Conners' Continuous Performance Test-II (Conners & MHS, 2000). Measures the participant's selective, sustained attention, and impulsivity. We include the T-scores for the errors of omission and variability. Although higher scores reflect more impairment, we reversed the scores to keep the interpretation of all tasks in the same direction (i.e., higher scores reflecting a better performance).

The Peabody Picture Vocabulary Test-III (PPVT-3)(Dunn et al., 1997), provides a measure of receptive vocabulary with age-based standard scores.

Wechsler Intelligence Scale for Children-III (WISC-III, 6.0 to 16-11 years of age)/Wechsler Preschool and Primary Scale of Intelligence-Revised (WPPSI-R, 2.5 to 7.5 years of age) (Wechsler, 1989, 1991). Participants received the age-appropriate version of the Wechsler scale. A two-subtest short-form, comprised of Vocabulary and Block Design, generated an IQ score.

Woodcock-Johnson Tests of Academic Achievement (WJ-III; Woodcock, McGrew, & Mather, 2001). Age-based standard scores were employed for the three subtests and overall score for reading and mathematics.

Wechsler Abbreviated Scales of Intelligence (WASI) (Stano, 1999). The WASI is built on the Wechsler scales of intellectual functioning. The two-subtest version (Vocabulary and Matrix Reasoning) generated a caregiver IQ score.

Clinical Measures

Kiddie Schedule for Affective Disorders and Schizophrenia- Present and Lifetime Version (K-SADS-PL)(J. Kaufman et al., 1997). This semi-structured interview was administered with caregivers and subjects, We also used archival records as sources of information. The KSADS-PL was modified to include additional information about: 1) life event questions, including traumatic events from the Child and Adolescent Psychiatric Assessment (Angold et al., 1995); 2) disorders not present in the KSADS-PL; 3) a structured scale was added to quantify symptom frequency; and 4) algorithms were created to determine Axis I psychiatric

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disorders based on DSM-IV criteria. Disorders were assigned a severity score of mild, moderate or severe. This modified version is available upon request.

The *failure to supervise* index was composed of adding positive responses to any of seven questions: a) neglect resulting in serious accidents; b) caregiver not knowing child's whereabouts; c) being left home alone; d) unexplained school absences; witnessing caregiver e) using drugs or f) drunk; and, g) exposure to inappropriate adult sexual activity (ά = .77). *Failure to provide* was defined using three questions regarding basic physical or medical care (ά = .71). *Physical abuse* was defined using five questions regarding discipline by a caregiver resulting in bruises or serious injury, or resulting in severe pain, scars, or an inability to sit or walk without pain; or being pushed into objects, shaken, burned or being threatened with a deadly weapon (ά = .41). *Witnessing interpersonal violence* was defined using ten questions regarding: a) witnessing a threatening or violent crime where significant injury occurred or could have occurred; b) witnessing a traumatic death; c) being the victim of a serious threatening or violent crime not perpetrated by a caregiver; d) being present during threats to important attachment figures; witnessing explosive arguments involving threatened or actual harm to e) caregivers or f) other family members; g) hearing about a serious fight involving threats or harm to attachment figures that occurred at home; h) witnessing physical rage; or, i) witnessing or, j) hearing about other family members' attempts to hurt themselves (ά = .76). *Emotional abuse* was defined by three questions regarding a caregiver making hurtful comments or swearing at the child or witnessing or hearing about other family members' physical abuse (ά = .48). All but one child with a history of neglect reported family violence from the interpersonal violence section and was excluded from the analyses.

Interviewers were individually trained to obtain 80% agreement for PTSD and over 90% agreement for the presence of any lifetime major Axis I disorder with a board certified child and adolescent psychiatrist and experienced child trauma interviewer (MDDB). Discrepancies were resolved by reviewing archival information or by re-interviewing the child or caregiver. If diagnostic disagreements were not resolved with this method, consensus diagnoses were reached among a child psychiatrist (MDDB) and child psychologist (SRH).

Statistical Analyses

Demographic variables and parent/caregiver IQ were examined using either Chi Square or analysis of variance (ANOVA). For neurocognitive domains and academic achievement, we conducted a series of MANOVAs across each of the domains: fine-motor, language, visual-spatial, memory/learning, attention/executive functions, and academic achievement. Follow-up pairwise comparisons (Tukey's LSD test) were conducted on the tasks within each domain, and on selected NEPSY supplemental scores.

Partial Eta Square (η_p^2) was reported to describe effect sizes for significant differences (Small < .06; Medium = .12; Large ≥ .16). Pearson Product Correlations were conducted between the *a priori* neuropsychological domains, IQ, and achievement measures, and PTSD and maltreatment-related variables for neglect subjects with PTSD, to examine the relationship between neurocognitive function and trauma measures. For this exploratory analysis, we engaged in a data reduction strategy to limit the number of neurocognitive variables. We calculated alpha coefficients to determine the internal consistency of each domain, and created domain scores by averaging the standard scores employed within each domain. For the IQ, reading, and mathematics domains, we employed the scores generated by the Wechsler scales and WJ-III, respectively. The primary intent was to reduce the number of tests into manageable domains and to provide support for their internal consistency. Significance testing was two-tailed with alpha = 0.05. Data are presented as mean ± standard deviation (SD). For the three-group comparisons, a Bonferonni Correction was indicated in Table-2.

Results

Neuropsychological Findings Across Groups

IQ—A significant group difference on IQ, with a moderate effect size was present (η_p^2 = .09). Follow-up pairwise comparisons revealed the two neglect groups to perform significantly lower than the controls, but not from one another. We did not control for IQ given its potential association with many of the neuropsychological variables used in this study and the possible subsequent elimination of group differences that otherwise would be present. We believe that IQ is not necessarily a confounding variable in this study but a consequence of neglect (De Bellis, 2001; Perez & Widom, 1994). A secondary analysis was conducted controlling for IQ in the data analysis to determine the effect of IQ on the results. See Table-2.

Fine-Motor—No group differences were present.

Language—MANOVA revealed significant group differences. Follow-up univariate analyses indicated group differences on NEPSY Speeded Naming, NEPSY Comprehension of Instructions, and PPVT-3, with moderate to large effect sizes. The findings suggest that the verbal fluency and overall receptive language capabilities for both Neglect Groups were significantly lower than the Controls, but the Neglect groups did not differ from one another.

Visual-Spatial—MANOVA revealed significant group differences. Follow-up univariate analyses showed the groups to differ on NEPSY Design Copying and NEPSY Block Construction with moderate effect sizes. Follow-up comparisons showed that the Neglect Groups were significantly lower on Block Construction, and the Neglect with PTSD Group was lower than the Controls on the NEPSY Design Copying.

Memory/Learning—MANOVA revealed significant group differences. Univariate findings revealed significant differences between the groups on all tasks with medium to large effect sizes. Pairwise comparisons revealed that the Neglect Groups performed significantly lower on Memory for Faces, Memory for Names, Narrative Memory tasks than the Controls. When examining the supplemental scores from the NEPSY Memory for Faces and Memory for Names subtests, significant group differences were apparent for Memory for Faces-Immediate Recall, F (2, 93) = 4.91, $p < .01$, and Memory for Faces-Delayed, F (2, 93) = 8.70, $p < .001$. For Immediate recall, pairwise comparisons showed the Neglect with PTSD Group performed lower than the Control Group. For Memory for Faces-Delayed, pairwise comparisons showed the Neglect with PTSD Group performed lower than both the Control and Neglect without PTSD Groups. Effect sizes ranged from moderate (η^2 = .1 to large (η^2 = .16), respectively. The Memory for Names Learning Trials supplemental score produced significant group differences, F (2, 93) = 9.23, $p < .001$. Similar findings were noted for the Memory for Names Delayed Recall supplemental score, F (2, 93) = 11.25, $p < .001$. Effect sizes were large (η^2 ranged from .17 to .20). Pairwise comparisons for each supplemental score revealed the two neglect groups to perform lower than controls, but the neglect groups did not differ from each other.

Attention/Executive Functions—A significant MANOVA was generated. Follow-up univariate analyses revealed specific group differences on NEPSY Tower and NEPSY Visual Attention, with medium to large effect sizes, respectively. Follow-up pairwise comparisons revealed the Neglect with PTSD Group to perform significantly lower than the

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Control Group, but no differences were noted between the two neglect groups or the Neglect without PTSD Group and the Controls. For NEPSY Visual Attention, both neglect groups performed significantly lower than the controls, but there were no group differences between the two neglect groups.

Academic Achievement Findings—A significant MANOVA was generated, indicating the presence of differences in academic achievement. Follow-up pairwise comparisons showed both neglect groups to perform lower than controls for reading; however, only the Neglect with PTSD Groups was lower than the controls for mathematics. The two neglect groups were not significantly different from each other on either reading or mathematics.

Group Comparisons Controlling for Intellectual Functioning

As shown in Table 2, after controlling for IQ, the neuropsychological domains of Language, Memory/Learning, and Attention/Executive Functions continued to reflect significant differences across groups.

Within the Language Domain, NEPSY Speeded Naming, NEPSY Comprehension, and PPVT-3 remained significantly different between the groups with moderate effect sizes.

For the Memory/Learning Domain, NEPSY Memory for Faces and NEPSY Memory for Names remained significantly different between groups, with moderate effect sizes. For the supplemental memory measures from the NEPSY, each of the four tasks reflected significant group differences. Memory for Faces—Immediate, F (2, 92) = 4.37, p < .02, Memory for Faces—Delayed, F (2, 92) = 7.01, p < .001, Memory for Names—Learning Trials, F (2, 92) = 6.34, p =.003, and Memory for Names—Delayed, F (2, 91) = 7.11, p < .001, persisted in showing group differences, with moderate effect sizes across tasks.

For Attention/Executive Functions the groups continued to be significantly different on NEPSY Tower and NEPSY Visual Attention, with moderate to large effect sizes.

Relationships Between PTSD Symptoms, Maltreatment Variables, and Neuropsychological Functions for the Neglect with PTSD Group

Using the *a priori* conceptual domains, we examined the internal consistency of each of the neuropsychological domains by calculating Cronbach's Alpha statistics: Fine-Motor (ά = .49), Language (ά = .68), Visual-Spatial (ά = .66), Memory/Learning (ά = .52), and Attention/Executive Functions (ά = .52). Note we did not include the PPVT-3 in the language domain as the inclusion of this within the domain lowered the overall alpha coefficient. We choose the subtest combination that generated the higher measure of internal consistency. The magnitude of these alpha coefficients suggests marginally acceptable internal consistency for each of the domains. This was most likely due to the small number of items/tasks contained within each domain. Satisfactory levels of alpha depend on test use, number of tests, and interpretation. Since relatively low (e.g., .50) levels of criterion reliability do not seriously attenuate validity coefficients (Schmitt, 1996), we used these domains to examine the relationships between PTSD symptoms, maltreatment variables, and neuropsychological domains.

Table 3 shows the Pearson Correlations produced between the neurocognitive domains, reading, and mathematics achievement, and child IQ; and the PTSD symptoms and maltreatment variables for the Neglect Group with PTSD. For the PTSD symptom variables, total PTSD symptoms negatively correlated with Language, Visual-Spatial, Attention/Executive Function, and the WJ-III Reading measures. PTSD severity negatively correlated with IQ. Negative correlations were seen between Language, WJ-III Reading Standard

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scores, and WJ-III Standard scores, and total PTSD cluster B symptoms of re-experiencing trauma. Cluster D symptoms negatively correlated with the Fine Motor Domain.

For the maltreatment variables, the Failure to Supervise Neglect Index negatively correlated with the WJ-III Reading and Mathematics Standard scores, and child IQ. The Witnessing Interpersonal Violence Index negatively correlated with WJ-III Reading Standard scores. Emotional abuse negatively correlated with WJ-III Reading and Mathematics Standard scores, and child IQ. All correlations, whether significant or not, were mainly in the expected direction with greater numbers of PTSD symptoms or maltreatment events associated with poorer cognitive function. We examined the maltreatment variables in the larger sample of neglected children and found similar findings.

Discussion

Neglected children showed significantly lower IQ, language, visual-spatial, learning/memory, and attention/executive functions and academic achievement than Controls. After controlling for child IQ, all measures remained significant except visual-spatial and academic achievement. These differences survived Bonferonni Corrections. Selected differences in complex visual attention, visual memory, verbal memory and learning, planning, problem solving, receptive language, and speeded naming were noted. Effect sizes were medium to large. Although academic skill differences were present, these did not persist when IQ was covaried. Covarying for IQ was not undertaken in previous studies (Perez & Widom, 1994). These findings suggest problems with school-based learning and a vulnerability to ongoing risk for neurodevelopmental challenges in neglected children, particularly in memory and attention/executive function. These challenges may become more severe with maturation, leading to school failure and poor quality of life (McGloin & Widom, 2001).

Our clinical assessment finding of experiences of family violence in all but one of the neglected children is interesting. Domestic violence is commonly seen in the child welfare system where to our knowledge, PTSD prevalence rates in neglected children were not reported. In the National Survey of Child and Adolescent Well-Being (Burns et al., 2004), high rates of intimate partner violence (28.7%) were self-reported using a parental self report measure, the Conflict Tactic Scales. These measures were significantly related to child internalizing and externalizing behavioral problems (Hazen et al., 2004). This report did not examine child PTSD. In our sample, 61 of 62 neglected children reported experiencing family violence resulting in a rate of 36% with PTSD. Our study examined family violence during a comprehensive interview with the caregiver and child; and using the conflict tactic scale and archival record reviews. This may have lead to the higher (and possibly more accurate) family violence rates in neglected children that we reported here.

Except for poorer memory for faces-delayed recall, we did not see major significant differences in neurocognitive abilities between the neglected children with PTSD and those without PTSD, although significant correlations were seen between PTSD symptoms and maltreatment indexes, and neurocognitive function. Many of the neurocognitive tests were lower in the group with PTSD. Our preliminary study may not have been adequately powered to test this hypothesis. These findings may also suggest that the DSM-IV PTSD taxon may not be relevant to the neurocognitive functioning of children in this age group. Children with threshold vs. subthreshold PTSD have similar impairment due to their PTSD symptoms (Carrion et al., 2001). A lower threshold of symptoms may be developmentally more appropriate when making a diagnosis of PTSD in preschool children as this diagnosis was originally intended for adult combat veterans (Scheeringa et al., 2006). This controversial area in the trauma literature is being addressed in the DSM-V.

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Our findings agreed with other studies showing lower IQ in neglected children (Perez & Widom, 1994), and work showing that IQ was inversely related to the severity of abuse (Carrey et al., 1995), particularly in our study, the emotional abuse index. We also showed that lower IQ was related to neglect (the failure to supervise index) and to total PTSD symptoms. Neglect was the only maltreatment subtype associated with cognitive delay and an associated IQ decline to the point of intellectual disability (Strathearn et al., 2001). In contrast to an adult combat-related PTSD study, our results did not show lower IQ in neglected subjects with PTSD (Macklin et al., 1998). In an MRI study, De Bellis and colleagues showed that the greater the number of years of experiencing the maltreatment trauma that lead to PTSD, the lower the IQ (De Bellis et al., 1999). In another cross-sectional study, lower IQ and Verbal IQ were significantly associated with a greater number of traumas and cluster B re-experiencing symptoms (Saltzman et al., 2006). Child maltreatment is a risk for PTSD after combat exposure (Bremner et al., 1993). We speculate that the studies showing lower IQ in adult PTSD may need to control for child maltreatment to address this issue. Note that IQ was lower in the caregivers of our neglect subjects. Since we were unable to obtain IQ measures on a significant percent of the biological parents of the neglected children, we cannot comment on the possibility of premorbid familial differences between groups. This is a limitation of this study. However, it should be noted that most parents who commit maltreatment were themselves maltreated as children, making these types of analyses inherently complex. Both neglect groups performed more poorly than controls in academic achievement agreeing with previous studies, which did not control for child IQ (Cicchetti & Toth, 1995; Gaudin Jr, 1999; Kendall-Tackett & Eckenrode, 1996; Kinard, 2001; Trickett & McBride-Chang, 1995). Achievement findings did not persist when controlling for IQ. Our results replicate and strengthen the previous findings of lower IQ and clarify the findings of lower academic achievement in neglected children.

Although few of measures for the Neglect Group fell within a deficient range, the findings of poorer performance in neglected children in language, visual-spatial, memory/learning and attention/executive function suggests relative weaknesses in neurological functioning involving stress sensitive areas such as the dorsolateral and medial prefrontal cortex, right hemisphere, and hippocampal regions in neglected children without the confounding effects of borderline IQ or mild mental retardation, a study exclusion, and a common outcome of child neglect (Perez & Widom, 1994). In a prospective neuroimaging study of children with impairing PTSD symptoms secondary to interpersonal violence, baseline PTSD symptoms predicted reductions in hippocampal volumes at 1–1.5 years follow-up (Carrion et al., 2007). For our sample, cognitive deficits may be more evident as our sample matures.

Using the NEPSY, non-abused and neglected children performed worse than controls on tests of auditory attention and response set while scoring higher than physically abused and neglected children for the Tower subtest (Nolin & Ethier, 2007). Our findings are generally consistent with this study; however, we did not uncover significant group differences in auditory attention, nor did we find that the Neglected Group performed higher than the controls on any task.

After controlling for child IQ, our findings revealed significant groups differences in language, learning memory, and attention/executive function. Our language finding extends the previous work, which shows poor language comprehension in neglect (Allen & Oliver, 1982). We saw significantly negative associations between higher PTSD and cluster B re-experiencing symptoms and lower language abilities. Neglected children have decreased verbal learning capacity (Lee & Hoaken, 2007; Pears & Fisher, 2005). Children with language impairments are likely to resort to physical aggression because their language disability prevents them from using verbal resolutions (N. J. Cohen, 2001), leading to disruptive behavioral problems. If these deficits are due to PTSD symptoms, then treatment

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with an evidence-based method, such as trauma-focused cognitive behavioral therapy (Cohen et al., 2004) may forestall this negative trajectory.

In our study, neglected children showed poorer verbal memory than controls. Delayed recall differences were seen in neglected children with PTSD. Research with adults who have a history of maltreatment showed memory deficits when compared to non-maltreated adults (Eisen et al., 2007). Memory and childhood neglect is understudied.

Visual-Spatial Processing was lower in neglected children. In this study, lower Visual-Spatial function was related to a greater number of PTSD symptoms. In one study, neglected children with physical abuse, compared to neglected children without physical abuse, tended to score much lower on tests of manual dexterity, auditory attention, and visual-motor integration (Nolin & Ethier, 2007). A review of 167 children with history of CPS maltreatment found that 45% of the 42 younger children (<2½ years old) exhibited significant developmental delay in sensorimotor functioning (Urquiza et al., 1994). Using the NEPSY, maltreated children in foster care had significantly lower scores for visuospatial processing (Pears & Fisher, 2005). These authors found that children placed in foster care before age two years had poorer visuospatial scores. In these later studies, it was not clear if brain injury such as shaken baby syndrome was exclusionary. We excluded subjects with neurological disorders in this investigation. We should also note that the Visual-Spatial finding did not persist after controlling for child IQ.

We did not see any difference in the fine motor domains. Since non-evidenced based treatments are in practice for sensory-motor integration disorder in neglected children, further empirical studies are needed to understand these neurocognitive functions and to provide evidenced-based treatments for neglected children.

The only significant finding noted was that the Neglect with PTSD Group performed poorer than the Neglect without PTSD Group and Controls on NEPSY Memory for Faces-Delayed Recall. The Neglect with PTSD Group performed poorer than the Control Group on NEPSY Design Copying and NEPSY Tower. These findings may reflect poorer visual-spatial, memory/learning, and attention/executive function in neglected children with PTSD. Given our correlational data, our findings of visual-spatial processing and attention/executive function were negatively correlated with total PTSD symptoms. Interestingly, we did not see any other significant correlations with maltreatment variables. These findings agree with previous work showing poorer attention/executive function in maltreated children with PTSD compared with a matched control group (Beers & De Bellis, 2002). However, it should be noted that the two maltreatment groups were not significantly different from each other on most cognitive domains. This may be due to small sample size. Future work in this pediatric area should consider cumulative PTSD symptoms as opposed to the DSM-IV PTSD taxon in their analyses (Carrion et al., 2001; Scheeringa et al., 2006).

Relationship of Neuropsychological Domains to PTSD and Maltreatment Measures in the Neglect Group with PTSD

All of the significant correlations and most of the correlations were in the expected direction, with lower IQ, neurocognitive function, and academic achievement being associated with more PTSD and maltreatment measures. Total PTSD and cluster B symptoms were negatively and significantly related to poorer language, visual-spatial, and attention/executive functions as well as poorer reading and mathematics achievement, while PTSD severity was negatively related to lower IQ. Maltreatment related indexes such as failure to supervise, witnessing family violence, and emotional abuse were negatively and significantly related to poorer reading and mathematics achievement and lower IQ. These correlations were clinically meaningful. Neurocognitive domains seem to be negatively effected by PTSD symptoms, while maltreatment related indexes were related to poorer academic achievement rather than specific neurocognitive domains. We may speculate that poor academic achievement is moderated by the effects of PTSD symptoms on cognitive function in neglected children. This indicates that a pattern of academic delay begins early in the educational process. Mandatory screening for family violence and PTSD symptoms in children referred for neglect that results in treatment with evidenced-based interventions may reverse these processes.

In summary, this study examined differences in IQ, academic achievement and neurocognitive functioning in neglected children with and without PTSD versus controls. Our findings continue to provide evidence for significantly lower performance of neglected children. Given the high prevalence of neglect and the limited literature on its neurocognitive outcomes, longitudinal neurobiological studies are warranted. Such studies may assist us in developing specific cognitive rehabilitative strategies to help improve neglected children's education and quality of life. Given that our findings correlated with PTSD symptoms and severity, the study of PTSD symptoms in addition to the study of the PTSD diagnosis may require further investigation in children. For those children who cannot be raised by their biological parents, secondary intervention such as adoption may booster lower IQs even for children adopted after age 4 years (Duyme et al., 1999). Given the appropriate investigations and resources, neglected children may fulfill their potentials (Koluchova, 1972, 1976).

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Table 1

Clinical Characteristics for the Neglected Children with PTSD (Group 1), Neglected Children with out PTSD (Group 2), and Non-Maltreated Children (Group 3).

Variable	Neglect with PTSD (1)	Neglect w/o PTSD (2)	Controls (3)	F	Group Differences	Pearson χ^2
N	22	39	45			
Chronological Age	8.30 (2.17) 4.25–12.92	7.19 (2.36) 3.08–12.83	7.77 (1.83) 4.17–11.42	2.01	--	
Hollingshead SES Score	37.91 (15.54)	38.62 (15.72)	39.38 (15.51)	.07	--	
% Right Handed	86.4%	82.1%	84.4%			4.60
% Caucasian	31.8%	53.85	31.1%			9.19
% Male	61.5%	45.5%	62.0%			1.68
% w/ Biological Parents	22.7%	41.0%	95.5%			41.63***
Child Height (Centimeters)	130.45 (13.51)	122.76 (16.99)	130.89 (14.78)	3.32*	2<3	
Child Weight (Kilograms)	30.51 (8.99)	28.52 (13.91)	33.53 (16.75)	1.29	--	
Caregiver IQ	98.67 (21.13)	101.21 (19.69)	106.69 (14.06)	3.54*	--	
Child IQ	92.36 (12.37)	94.51 (14.44)	101.96 (13.89)	4.76*	1,2<3	
Total PTSD Symptoms	9.86 (2.19)	2.72 (2.60)	--	208.65***	2<1	
% with DSM-IV PTSD	100%	0%	0%			60.00***

* $p < .05$;

** $p < .01$;

*** $p < .001$

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Table 2

Neuropsychological Findings for the Neglected Children with PTSD (Group 1), Neglected Children with out PTSD (Group 2), and Non-Maltreated Children (Group 3)

				Not Controlling for Child IQ			Controlling for Child IQ	
Cognitive Domain	Neglect with PTSD (1)	Neglect w/o PTSD (2)	Controls (3)	Statistic	Partial Eta^2	Pairwise Comparisons	Statistic	Partial Eta^2
Fine-Motor				$F_{6,180}$ =.86	.03		$F_{6,178}$=.68	.02
NEPSY Fingertip Tapping	10.50 (1.90)	10.09 (2.23)	10.24 (2.37)	$F_{2,92}$=.21	.01	--	$\mathbf{F_{2,91}}$.=.22	.01
NEPSY Imitative Hand Movements	9.05 (2.93)	9.12 (2.21)	9.69 (2.48)	$F_{2,92}$.=.68	.01	--	$\mathbf{F_{2,91}}$.=.14	.00
NEPSY Visuomotor Precision	8.00 (3.29)	8.85 (2.80)	9.24 (2.02)	$F_{2,92}$.=1.53	.03	--	$\mathbf{F_{2,91}}$.=1.47	.03
Language				**$F_{8,174}$.=4.00*****	**.16**		**$F_{8,172}$.=2.87****	**.12**
NEPSY Phonological Processing	8.45 (3.27)	8.91 (4.18)	10.41 (2.95)	$F_{2,90}$ =2.79	.06	--	$F_{2,89}$ =.53	.01
NEPSY Speeded Naming	8.00 (2.85)	7.34 (2.73)	9.80 (2.72)	**$F_{2,90}$ =7.73***** *A*	.15	1,2<3	**$F_{2,89}$ =4.47***	.09
NEPSY Comprehension	8.60 (3.24)	9.19 (2.82)	11.29 (2.45)	**$F_{2,90}$ =8.45***** *A*	.16	1,2<3	**$F_{2,89}$ =4.19***	.09
Peabody Picture Vocabulary Test	94.55 (11.29)	92.05 (10.70)	106.05 (14.07)	**$F_{2,90}$ =11.30***** *A*	.20	1,2<3	**$F_{2,89}$ =6.21*****A*	.12
Visual-Spatial				**$F_{6,164}$.=2.54***	**.09**		**$F_{6,162}$.=1.51**	**.05**
NEPSY Design Copying	9.25 (2.92)	10.16 (2.58)	11.53 (2.71)	**$F_{2,84}$=4.94**** *A*	.11	1<3	$F_{2,83}$ =2.84	.06
NEPSY Arrows	10.10 (2.43)	9.81 (2.70)	10.86 (2.73)	$F_{2,84}$=1.40	.03	--	$F_{2,83}$ =.61	.02
NEPSY Block Construction	7.45 (2.28)	7.48 (2.54)	9.14 (2.53)	**$F_{2,84}$=4.77***	.10	1,2<3	$F_{2,83}$ =2.17	.05
Memory/Learning				**$F_{6,180}$ =5.65*****	**.16**		**$F_{6,178}$=4.33*****	**.13**
NEPSY Memory for Faces	10.24 (2.97)	12.09 (2.41)	13.00 (2.58)	**$F_{2,92}$ =7.82***** *A*	.15	1,2<3	**$F_{2,91}$ =6.49**** *A*	.13
NEPSY Memory for Names	7.24 (3.29)	7.81 (3.61)	10.71 (3.19)	**$F_{2,92}$ =10.36***** *A*	.18	1,2<3	**$F_{2,91}$ =7.11***** *A*	.14
NEPSY Narrative Memory	10.48 (2.27)	9.91 (2.44)	11.83 (3.28)	**$F_{2,92}$ =4.53***	.09	1,2<3	$F_{2,91}$ =2.52	.05
Attention/Executive Function				**$F_{10,170}$ =3.81*****	**.18**		**$F_{10,168}$ =3.04*****	**.15**
NEPSY Tower	9.35 (2.01)	10.19 (2.76)	11.48 (2.01)	**$F_{2,89}$ =6.34**** *A*	.13	1<3	**$F_{2,88}$ =5.16**** *A*	.11
NEPSY Auditory Attention	10.60 (1.85)	11.06 (1.68)	11.40 (1.30)	$F_{2,89}$ =1.76	.04	--	$F_{2,88}$ =.92	.02

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				Not Controlling for Child IQ			Controlling for Child IQ	
Cognitive Domain	**Neglect with PTSD (1)**	**Neglect w/o PTSD (2)**	**Controls (3)**	**Statistic**	**Partial Eta²**	**Pairwise Comparisons**	**Statistic**	**Partial Eta²**
NEPSY Visual Attention	8.40 (3.07)	10.06 (2.27)	12.03 (2.73)	$\mathbf{F_{2,89} = 13.22}^{***A}$	.23	1,2<3	$\mathbf{F_{2,88} = 9.64}^{***A}$	.18
CPT-II Omissions	61.06 (20.80)	63.89 (19.90)	55.20 (11.43)	$F_{2,89} = 2.44$	.05	--	$F_{2,88} = 1.62$	.04
CPT-II Variability	56.46 (12.83)	60.67 (10.50)	56.76 (11.03)	$F_{2,89} = 1.32$	.03	--	$F_{2,88} = 1.20$	.03
Academic Achievement				$\mathbf{F_{4,142} = 3.19}^{**}$	**.08**		$F_{4,140} = 1.67$	.05
Reading	95.87 (16.75)	97.22 (10.73)	105.97 (10.93)	$\mathbf{F_{2,72} = 5.40}^{**A}$	.13	1,2<3	$F_{2,71} = 2.28$	.06
Mathematics	98.19 (12.92)	101.70 (8.72)	107.69 (10.63)	$\mathbf{F_{2,72} = 5.10}^{**A}$	.12	1<3	$F_{2,71} = 2.48$	.07

* $p < .05$;

** $p < .01$;

*** $p < .001$;

A p<.05 with Bonferonni Correction within cognitive domain

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Table 3

Pearson Correlations between the Neuropsychological Domains and Maltreatment-Related Variables for Neglected Children with PTSD

Cognitive Domain	Total PTSD Symptoms	PTSD Severity	Cluster B	Cluster C	Cluster D	Failure to Supervise Index	Failure to Provide Index	Witnessing Family Violence Index	Physical Abuse Index	Emotional Abuse Index
Fine Motor Domain Score	−.27	−.36	−.07	.07	−.57**	−.29	−.07	−.16	.08	−.13
Language Domain Score	−.50*	−.21	−.57**	−.20	−.17	−.28	−.16	−.42	−.37	−.38
Visual-Spatial Domain Score	−.61**	−.42	−.40	−.37	−.43	−.37	−.16	−.40	−.38	−.27
Memory/Learning Domain Score	−.21	−.12	−.16	−.07	−.18	−.26	−.13	−.10	−.20	−.43
Attention/Executive Function Domain Score	−.48*	−.10	−.28	−.31	−.31	−.36	−.17	−.13	−.14	−.36
WJ-III: Reading Standard Score	−.54*	−.42	−.54*	−.30	−.19	−.64**	−.46	−.64**	−.45	−.52*
WJ-III: Mathematics Standard Score	−.38	−.11	−.48*	−.21	.00	−.58**	−.09	−.44	−.20	−.48*
Subject's IQ	−.37	−.58**	−.32	−.26	−.13	−.55**	−.33	−.36	−.39	−.64***

* $p < .05$;

** $p < .01$;

*** $p < .001$