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Child Maltreatment and Executive Functioning in Middle Adulthood: A Prospective Examination

Valentina Nikulina[*] and **Cathy Spatz Widom**
Psychology Department John Jay College of Criminal Justice City University of New York

Abstract

Objective—There is extensive evidence of negative consequences of childhood maltreatment for IQ, academic achievement, and post-traumatic stress disorder (PTSD) and increased attention to neurobiological consequences. However, few prospective studies have assessed the long-term effects of abuse and neglect on executive functioning. The current study examines whether childhood abuse and neglect predicts components of executive functioning and nonverbal reasoning ability in middle adulthood and whether PTSD moderates this relationship.

Method—Using a prospective cohort design, a large sample (*N* = 792) of court-substantiated cases of childhood physical and sexual abuse and neglect (ages 0-11) and matched controls were followed into adulthood (*mean age* = 41). Executive functioning was assessed with the Trail Making B test and non-verbal reasoning with Matrix Reasoning. PTSD (DSM-III-R lifetime diagnosis) was assessed at age 29. Data were analyzed using ordinary least squares regressions, controlling for age, sex, and race and possible confounds of IQ, depression, and excessive alcohol use.

Results—In multivariate analyses, childhood maltreatment overall and childhood neglect predicted poorer executive functioning and non-verbal reasoning at age 41, whereas physical and sexual abuse did not. A past history of PTSD did not mediate or moderate these relations.

Conclusions—Childhood maltreatment and neglect specifically have a significant long-term impact on important aspects of adult neuropsychological functioning. These findings suggest the need for targeted efforts dedicated to interventions for neglected children.

Keywords

Childhood physical abuse; sexual abuse; neglect; executive functioning; non-verbal reasoning; PTSD

Introduction

In the United States, it is estimated that over a million children are maltreated every year (Sedlak et al., 2010). Consequences of child abuse and neglect have included psychiatric disorders (Johnson, Cohen, Brown, Smailes, & Bernstein, 1999; MacMillan et al., 2001; Neumann, Houskamp, Pollock, & Briere, 1996; Widom, DuMont, & Czaja, 2007), health risk behaviors (Topitzes, Mersky, & Reynolds, 2010; Wilson & Widom, 2008), poor physical health (Danese et al., 2009; MacMillan, 2010; Widom, Czaja, Bentley, & Johnson, 2012), criminal behavior (Caspi et al., 2002; Widom, 1989b), and academic underachievement and lower IQ (Jaffee & Maikovich Fong, 2011; Perez & Widom, 1994).

[*]Corresponding author Address: John Jay College of Criminal Justice Psychology Department 524 W 59th Street, Suite # 63.05 New York, NY 10019 USA vnikulina@jjay.cuny.edu (212) 237-8975 (T) (212) 484-1199 (F) .

Some researchers have hypothesized that exposure to early childhood experiences, such as abuse and/or neglect, have a detrimental effect on brain development leading to neurobiological alterations (Anderson, 2003; Beers & DeBellis, 2002; Bremner & Vermetten, 2001; De Bellis et al., 1999; Ito, Teicher, Glod, & Ackerman, 1998). Early chronic developmental trauma is thought to disrupt hypothalamic-pituitary-adrenal (HPA) axis activity and brain regions associated with it (Bremner et al., 2003; Wilson, Hansen, & Li, 2011), including the prefrontal cortex and its functions. Some evidence suggests that the prefrontal cortex has one of the most protracted developmental periods and may be particularly vulnerable to chronic stressful and traumatic experiences, such as childhood maltreatment (Wilson et al., 2011). These hypothesized effects of early trauma and stress on cortical development are thought to explain cognitive and academic deficiencies associated with maltreatment, including deficits in executive functioning and non-verbal reasoning. Executive functioning and nonverbal reasoning are broad concepts that incorporate a range of tasks responsible for planning, inhibition, organization and monitoring of complex behaviors, include working memory, cognitive flexibility, sustained attention and non-verbal problem solving and relational reasoning (Aupperle, Melrose, Stein, & Paulus, 2012; Ferrer, O'Hare, & Bunge, 2009), and are heavily dependent on prefrontal cortex functioning. In the manuscript we focus on one component of executive functioning, cognitive flexibility, and on non-verbal reasoning assessed by relational problem solving.

While studies of maltreated children have reported differences in neuropsychological tests including non-verbal reasoning and cognitive flexibility (Beers & De Bellis, 2002; Schoeman, Carey, & Seedat, 2009), studies with adults who retrospectively report abuse histories find mixed results (Twamley, Hami, & Stein, 2004). In one study, women who reported histories of sexual abuse exhibited deficits in cognitive flexibility/control, assessed by the Go/No-Go/Stop task (Navalta, Polcari, Webster, Boghossian, & Teicher, 2006). Other studies of adults who reported histories of neglect, sexual and physical abuse did not find differences in cognitive flexibility as measured by the Intra/Extra Dimensional Shift, a part of the Cambridge Neuropsychological test Automated battery (Gould et al., 2012; Majer, Nater, Lin, Capuron, & Reeves, 2010). Thus, it is difficult to compare these studies, because of differences in types of maltreatment studied and assessment instruments used.

Because both theory and research link post-traumatic stress disorder (PTSD) to prefrontal cortex activity (Richert, Carrion, Karchemskiy, & Reiss, 2006), it has been suggested that the HPA axis becomes permanently deregulated in patients with PTSD, altering their cognitive functioning (Shea, Walsh, Macmillan, & Steiner, 2005; Yehuda, 2001). Brain imaging studies have reported that children exhibiting symptoms of PTSD have reduced prefrontal cortex gray matter volume (Richert et al., 2006). This literature has been linked to the findings that show high rates of PTSD in children exposed to maltreatment (Ackerman, Newton, McPherson, Jones, & Dykman, 1998; Widom, 1999). However, research with maltreated children who develop PTSD reveals conflicting results on assessments of cognitive flexibility. Samuelson and colleagues found that children with PTSD after exposure to intimate partner violence did not differ from traumatized children without PTSD on cognitive flexibility assessed by the Stroop colorword interference task (Samuelson, Krueger, Burnett, & Wilson, 2010). Conversely, Mezzacappa, Kindlon, and Earls (2001) compared three groups of children (those hospitalized for psychiatric disorders with a history of childhood sexual or physical abuse, those in the same psychiatric hospital without a trauma history, and healthy community controls) and found that the psychiatric patients overall performed worse on a flexibility tasks (Go-No/Go) than the community sample, suggesting that it was psychiatric functioning and psychopathology associated with the deficits rather than the trauma history.

The effects of maltreatment and PTSD may be confounded in these studies and yet sparse research has attempted to disentangle the effects of maltreatment and PTSD on cognitive functioning. Because not everyone who experiences traumas develops PTSD, studies that compare samples with PTSD to controls who do not have a trauma history cannot differentiate the effects of trauma from PTSD (Gunnar & Quevedo, 2007). Alternatively, studies comparing traumatized participants with PTSD to traumatized participants without PTSD are able to address the effects of PTSD, but not the traumatic experience (Schoeman, Carey, & Seedat, 2009).

In community samples recruited through specialty services (e.g., interpersonal violence centers or emergency rooms), PTSD (and not trauma) was linked to cognitive flexibility deficits assessed by Trail Making B (LaGarde, Doyon, & Brunet, 2010; Stein, Kennedy, & Twamley, 2002). At the same time, studies with college undergraduates failed to detect differences in cognitive flexibility among controls without any trauma, traumatized patients with PTSD, and traumatized patients without PTSD assessed with Trail Making B (Leskin & White, 2007; Twamley et al., 2004) and similar results were found in studies of non-verbal reasoning in veterans (Crowell, Kieffer, Siders, & Vanderploeg, 2002). However, it is difficult to compare these studies because of difference in the kinds of traumatic experiences reported. It is also possible that the use of a sample of college students (who report histories of maltreatment) by itself indicates some higher level of neuropsychological functioning compared to young people in the general population who do not make it to college (Rind, Tromovitch, & Bauserman, 1998).

In sum, this body of literature reveals mixed findings about the role of childhood maltreatment and PTSD on executive functioning and non-verbal reasoning that may be related to a number of factors. Some of the discrepancies may be due to differences in the samples studied [females or mixed samples (Stein et al., 2002), institutionalized or hospitalized children (Mezzacappa et al., 2001; Pollak et al., 2010), college students of veterans (Crowell et al., 2002; Leskin & White, 2007)], types of child maltreatment [physical abuse and sexual abuse (Mezzacappa et al., 2001), neglect (Beers & De Bellis, 2002) or witnessing domestic violence (Samuelson et al., 2010)], criteria for maltreatment [retrospective self-reports (Navalta et al., 2006) or official reports (Beers & De Bellis, 2002)], and age of participants that make it difficult to compare across studies. Retrospective reports are subject to recall bias and limit generalization to those who remember being maltreated (Fergusson, Horwood, & Woodward, 2000). Furthermore, finding differences in brain structures in cross-sectional studies is ambiguous because it is possible that these neurobiological deficits represent a risk factor for child maltreatment, rather than a consequence of exposure. Prospective longitudinal studies are needed to validate and untangle the nature of these relationships. To our knowledge, this is the first prospective longitudinal study of maltreated children that has followed them up and assessed executive functioning in adulthood.

The present study has several advantages. We use data from a prospective study of court-substantiated cased of childhood maltreatment and matched controls who were followed into adulthood and assessed at age 41. We use standardized assessments of neuropsychological functioning (Trail Making) and non-verbal reasoning (Matrix Reasoning) and we examine the role of PTSD as a potential mediator or moderator of the hypothesized relationships. We also control for potential confounding factors of alcohol and depression because of the high risk of maltreated children for problems with alcohol (Widom, Ireland, & Glynn, 1995) and depression (Widom et al., 2007) and because of the cognitive deficits associated with these disorders (Fossati, Ergis, & Allilaire, 2002; Goldstein et al., 2004). We also control for IQ to insure that executive functioning and non-verbal reasoning deficits do not simply reflect deficits in general intellectual functioning associated with child abuse/neglect (Perez &

Widom, 1994). Finally, we have a diverse sample of males, females, Whites, and Blacks and individuals with documented histories of three types of childhood maltreatment (physical and sexual abuse and neglect) that can be compared.

We ask four fundamental questions: (1) Does childhood maltreatment predict executive functioning and non-verbal reasoning deficits in middle adulthood? (2) Are there differences in the impact of child maltreatment on executive functioning and non-verbal reasoning by type of childhood abuse and/or neglect (sexual abuse, physical abuse and neglect)? (3) Does childhood maltreatment predict executive functioning and non-verbal reasoning deficits in middle adulthood, after other factors (IQ, current levels of depression, or excessive alcohol consumption) are taken into consideration? (4) Does a history of PTSD moderate or mediate the relation between child abuse/neglect and executive functioning and non-verbal reasoning deficits in middle adulthood?

Methods

Design and Participants

Data were collected as part of a large prospective cohort design study (Leventhal, 1982; Schulsinger, Mednick, & Knop, 1981) in which abused and/or neglected children were matched with non-abused and non-neglected children and followed into adulthood. Since it is not possible to assign subjects randomly to groups, the assumption of equivalency for the groups is an approximation. For complete details of the study design, see Widom (1989a).

The original sample of maltreated children (N = 908) was composed of all substantiated cases of childhood physical, sexual abuse and neglect processed from 1967 to 1971 in the county juvenile (family) or adult criminal courts of a Midwestern metropolitan area. Cases of abuse and neglect were restricted to children age 0-11 at the time of the incident and, therefore, represent childhood maltreatment.

A control group of children without documented histories of childhood abuse and/or neglect (N = 667) was matched with the abuse/neglect group on age, sex, race/ethnicity, and approximate family social class during the time that the abuse and neglect cases were processed. This matching was important because it is theoretically plausible that any relationship between child abuse and neglect and subsequent outcomes is confounded with or explained by social class differences (Adler et al., 1994; Bradley & Corwyn, 2002; Conroy, Sandel, & Zuckerman, 2010; MacMillan et al., 2001; Widom, 1989b). The matching procedure used here is based on a broad definition of social class that includes neighborhoods in which children were reared and schools they attended (Watt, 1972). Children who were under school age at the time of the abuse and/or neglect were matched with children of the same sex, race, date of birth (± 1 week), and hospital of birth through the use of county birth record information. For children of school age, school records were used to find matches with children of the same sex, race, date of birth (± 6 months), class in elementary school during the years 1967 to 1971, and home address. Overall, matches were found for 74% of the abused and neglected children.

The initial phase of the study compared the abused and/or neglected children to the matched comparison group on juvenile and adult criminal arrest records (Widom, 1989b) and found that abused and neglected children were at increased risk for delinquency, adult criminality, and violence, compared to the matched controls. However, because the majority of maltreated children did not become delinquent or criminal, a second phase of the project was begun to determine what had happened to these children in other aspects of their functioning. This involved locating and interviewing the abused and/or neglected and comparison groups during 1989-1995, approximately 22 years after the incidents of abuse

and neglect (N = 1,196). Subsequent follow-up interviews were conducted in 2000-2002 (N = 896) and again in 2003-2005 (N = 807). This paper uses information from the first interview (1989-1995) and the third interview (2003-2005) when executive functioning and non-verbal reasoning were assessed.

Although there was attrition associated with death, refusals, and our inability to locate people over the various waves of the study, the composition of the sample at the four time points has remained about the same. Table 1 shows demographic characteristics of the sample at the first and current interview. The current sample of 792 is composed of maltreated (57%) and control (43%) participants who completed the neuropsychological assessment. The sample is mean age 41.2 (range 32.0-49.0), 53% female, 59% non-Hispanic White, 34% Black, not of Hispanic origin, and 4% Hispanic. The sample is skewed toward the lower end of the socioeconomic spectrum: 60% completed high school, 54.9% held unskilled or semiskilled jobs, and only 13.7% held semi-professional or professional jobs (Hollingshead, 1975).

Procedures

Interviewers were blind to the purpose of the study and to the inclusion of an abuse/neglect group. Participants were also blind to the purpose of the study and were told that they had been selected to participate as part of a large group of individuals who grew up in that area during the late 1960s and early 1970s. Institutional Review Board (IRB) approval was obtained for each wave of the study, including the most recent approval from the IRB of the City University of New York. Participants provided written or verbal (for those with limited reading ability) informed consent.

Measures and Variables

Childhood maltreatment—Childhood maltreatment was assessed through review of official records processed during the years 1967 to 1971. Neglect cases reflected a judgment that the parents' deficiencies in child care were beyond those found acceptable by community and professional standards at the time. These cases represented extreme failure to provide adequate food, clothing, shelter, and medical attention to children. Physical abuse cases included injuries such as bruises, welts, burns, abrasions, lacerations, wounds, cuts, bone and skull fractures, and other evidence of physical injury. Sexual abuse charges varied from relatively non-specific charges of "assault and battery with intent to gratify sexual desires" to more specific charges of "fondling or touching in an obscene manner," sodomy, incest, and rape. Eleven percent of the sample experienced more than one type of maltreatment.

Cognitive Flexibility and Processing Speed—Trail Making tests (A and B) were used to assess different functions at age 41. Trail Making A was followed by Trail Making B as is standard practice. Trail Making Test B (Reitan, 1958) requires participants to alternate sequencing of letters and numbers and has been used extensively as an assessment of executive functioning, particularly switching of cognitive sets (Mitrushina, Boone, & D'Elia, 1999; Reitan, 1958). Trail Making A requires participants to connect numbers as quickly as possible and assesses processing and psychomotor speed (Hays, 1995; Reitan, 1992). Trail Making A and B scores were natural log transformed to correct for high positive skew. Higher scores on Trail Making A and B indicate more time (measured in seconds) completing the task and indicate poorer performance.

Non-verbal Reasoning—The Matrix Reasoning test, a subtest of the WAIS-III (Wechsler, 1997) that assesses non-verbal reasoning and problem solving, requires participants to identify a pattern and complete it with a missing part selected from presented

options. Scores on Matrix Reasoning are highly correlated with other assessments of non-verbal reasoning, including the Halstead Category Test subtests (Titus, Retzlaff, & Dean, 2002) and arithmetic subtest of the Luria-Nebraska Neuropsychological Battery (Devaraju-Backhaus, Espe-Pfeifer, Mahrou, & Golden, 2001), and with executive functioning assessments (Hill et al., 2010; Zook, Welsh, & Ewing, 2006). Matrix reasoning tasks have been shown to activate the dorsolateral and rostrolateral prefrontal cortex (Ferrer et al., 2009; Masunaga, Kawashima, Horn, Sassa, & Sekiguchi, 2008). Higher scores on Matrix Reasoning represent correctly completed items and better performance.

Post-traumatic Stress Disorder (PTSD)—During the 1989-1995 interviews when participants were approximately age 29, the NIMH Diagnostic Interview Schedule-III-Revised (Robins, Helzer, Cottler, & Goldring, 1989) was used to determine whether the participants met the criteria for a DSM-III-R lifetime diagnosis of PTSD (American Psychiatric Association, 1987). The DIS-III-R is a highly structured interview schedule designed for use by lay interviewers. Field interviewers received a week of study-specific training and successfully completed practice interviews before beginning the study interviews. Field interviewer supervisors recontacted a random 10% of the respondents for quality control. Frequent contacts between field interviewers and supervisors were held to prevent interview drift, to monitor quality, and to provide continuous feedback. Adequate reliability for the DIS has been reported (Robins, Helzer, Croughan, & Ratcliff, 1981). Individuals with documented histories of child abuse and neglect have been shown to be at increased risk for PTSD (Widom, 1999).

Demographic characteristics—Age, sex, and race/ethnicity were used as control variables. Age at the time of assessment was used as a control variable because advancing age has been related to neuropsychological functioning (Brickman et al., 2006). Sex was coded as female (1) and male (0); race was coded as White, non-Hispanic (1) and Other (0). We also control for IQ, concurrent depression, and excessive alcohol use because these characteristics have been shown to relate to assessments of executive functioning and non-verbal reasoning (Fossati et al., 2002; Goldstein et al., 2004).

IQ—IQ was assessed during the 1989-1995 interviews when participants were mean age 29. The Quick Test (Ammons & Ammons, 1962), an easily administered measure of current level of verbal intelligence where the subject can point to a picture on a card, was used. Quick Test scores correlate highly with WAIS full scale (.79 .80) and verbal (.79 .86) IQs (Dizzone & Davis, 1973).

Depression symptoms—Depression was assessed with the Center for Epidemiological Studies Depression Scale (CES-D) concurrent with the assessment of executive functioning (2003-2005). The CES-D is a 20-item self-report instrument that asks individuals to report the extent to which they were bothered by symptoms of depression during the past week, using a Likert scale ranging from “Less than 1 day” to “5-7 days.” Scores range from 0-60 and scores below 15 are categorized as no depression, 15 -21 are categorized as mild to moderate, and scores over 21 as major depression. The average in the current study is 11.36, with scores ranging from 0 – 56. The CES-D has been shown to have excellent internal reliability of .85 to .92 (Radloff, 1977) and used to measure depression in multiple settings (Beekman, Deeg, Van Limbeek, & Braam, 1997; Radloff, 1977). The alpha reliability coefficient in the current study is .92.

Excessive alcohol use at age 41—During the 2003-2005 interview (concurrent with the executive functioning assessment), participants were asked “On how many days in the past 12 months did you drink an alcoholic beverage?” and “On the days that you drank

during the past year, how many drinks did you usually have?" Participants who reported drinking more than 60 drinks a month in the past year were considered to have engaged in excessive drinking (coded "1") versus those who did not (coded "0").

Data Analysis

We first conducted t-tests to determine whether individuals with documented histories of child maltreatment performed worse on outcomes of Trail Making A and B and Matrix Reasoning than controls. We then regressed Trail Making A and B and Matrix Reasoning onto child maltreatment (and individual types of maltreatment) in a series of hierarchical regressions using Ordinary Least Squares Regressions (OLS) with controls in four separate steps: (1) age, race, and sex (ARS); (2) ARS and IQ; (3) ARS, IQ, and past history of PTSD diagnosis; and (4) ARS, IQ, PTSD diagnosis, and depression and excessive alcohol consumption concurrent with the executive functioning assessment.

Mediation (Baron & Kenny, 1986) requires at least two significant relations (1) between child maltreatment (predictor) and PTSD (the mediator) and (2) between PTSD (the mediator) and the outcome. Moderation was assessed using OLS regressions by centering the main effects and multiplying them to create the interaction term. Interaction terms were entered into regressions after controls and main effects (Cohen, Cohen, West, & Aiken, 2002)

Results

Childhood Maltreatment and Executive Functioning and Non-verbal Reasoning

Table 2 presents bivariate analyses showing that child maltreatment in general, and neglect in particular, predict poorer performance on Trail Making B. Childhood maltreatment, neglect and physical abuse are also related to poorer performance on Matrix Reasoning. Childhood maltreatment in general, neglect, physical abuse, and sexual abuse (only marginally) predicted poorer performance on Trail Making A, an assessment of processing speed.

Does childhood maltreatment predict executive functioning and non-verbal reasoning deficits in middle adulthood, after other factors (IQ, current levels of depression, or excessive alcohol consumption) are taken into consideration?

Tables 3-5 present the results of a series of hierarchical regressions. Our findings (Table 3) show that childhood maltreatment overall and neglect, in particular, predicted Matrix Reasoning and Trail Making B scores despite the introduction of demographic characteristics, IQ, PTSD diagnosis at age 29, and depression and alcohol consumption at age 41. Neither sexual nor physical abuse predicted Trail Making B scores. Childhood physical abuse no longer predicted poorer performance on Matrix Reasoning after IQ was introduced (Table 4). Finally, Table 5 shows that child maltreatment and neglect did not predict Trail Making A after controls for age 29 IQ and PTSD diagnosis were introduced, whereas physical and sexual abuse no longer predicted Trail Making A after controlling for IQ.

Does a history of PTSD mediate or moderate the relation between childhood maltreatment and executive functioning in adulthood?

To test for mediation, the predictor (in this case, child maltreatment) must be related to the outcome (our indicators of executive functioning and non-verbal reasoning). Second, the predictor has to be related to the mediator and, third, the mediator has to be related to the outcomes. However, our findings showed that only abuse/neglect in general and neglect in particular were related to executive functioning and, thus, mediation could only be assessed

for these predictors. As seen earlier in Tables 3 and 4, because there was no relationship between the hypothesized mediator (PTSD diagnosis) and Trail Making B and Matrix Reasoning, the third necessary condition for mediation was not met and, therefore, there is no mediation.

To examine whether PTSD moderates the relationship between child maltreatment and executive functioning, we conducted a series of regression equations that included the interaction between group (abuse/neglect, neglect, sexual abuse, and physical abuse versus control) and past history of PTSD. None of the types of maltreatment interacted with PTSD diagnosis at mean age 29 to predict Matrix Reasoning or Trail Making B (controlling for age, race, sex, and IQ). The results did not change with the introduction of additional covariates of depression symptoms and excessive alcohol consumption. Results are not shown but available from authors upon request.

Discussion

The current study sought to determine whether childhood maltreatment overall and specific types of maltreatment (neglect, physical abuse and sexual abuse) predicted executive functioning and non-verbal reasoning at age 41. We examined this question using data from a prospective cohort design study with individuals with documented histories of child maltreatment and matched controls that were followed up and assessed in middle adulthood. Our results showed that childhood maltreatment, and specifically neglect, but not physical or sexual abuse, predicted deficits in middle adulthood as indicated by poorer performance on the Trail Making B test (an indicator of executive functioning) and Matrix Reasoning (problem solving/non-verbal reasoning). These deficits in Trail Making B and Matrix Reasoning were not explained by demographic characteristics, IQ or concurrent levels of depression and excessive alcohol consumption that might have affected performance. We also did not find that a past history of PTSD mediated or moderated these relations.

While our results are consistent with some other research indicating that neglected children perform worse than controls on non-verbal reasoning assessments (De Bellis, Hooper, Spratt, & Woolley, 2009), we did not find that sexual or physical abuse predicted deficits in neuropsychological functioning as reported by other studies (Navalta et al., 2006). It is possible that differences between the design of this study and that of other studies could account for inconsistencies. To our knowledge, this is the first prospective study to assess maltreatment in childhood and executive functioning and non-verbal reasoning in adulthood. In addition, our sample represents a range of functioning and is not restricted to mentally ill participants (Gould et al., 2012). It is also important to note that although our sample of physically abused and sexually abused children was smaller than our sample of neglected children, it is unlikely that the null results are due to low power. Inspection of Tables 3 and 4 indicates that betas (with all controls in the model) for overall maltreatment and neglect predictors are large and range from .08 to .14, while comparable betas for sexual and physical abuse range from 0 to .02.

Bivariate analyses of processing speed show that all types of maltreatment are related to poorer function on Trail Making A, compared to controls. Childhood sexual abuse only marginally predicted Trail Making A (not Trail Making B and Matrix Reasoning) and this effect disappeared with controls for IQ. The deficits observed between maltreated children on Trail Making A in comparison to controls become non-significant after IQ (for maltreatment in general and all three types) and PTSD (for maltreatment in general and neglect) were introduced. These findings suggest that the differences between abuse/neglect and control groups in performance on Trail Making A may be a function of prior differences in IQ (Perez & Widom, 1994) and PTSD (Widom 1999).

In contrast, differences between the abuse/neglect and control groups on Trail Making B and Matrix Reasoning were not eliminated with the introduction of IQ or PTSD. These findings provide support for the hypothesis that implicates the prefrontal cortex in these deficits and are consistent with previous work that postulates HPA-axis responses to stress and potential deregulation in situations of severe and chronic early life stress, such as childhood neglect (Bremner et al., 2003; Wilson et al., 2011).

In addition, our findings suggest that aspects of executive functioning associated with the prefrontal cortex are particularly salient for the development of neglected children. In the current study, cases of neglect represent those in which there was a judgment that the child's caregivers' failed to provide basic needs of the child, leaving him/her without food, clothing, shelter, or medical care. Previous work has suggested that lack of appropriate care and stimulation (Pollak et al., 2010) can have detrimental effects on a range of brain areas (Teicher et al., 2003) including the prefrontal cortex, one of the regions that is responsible for executive functions and non-verbal reasoning. Recent work shows differences between brain matter volumes in middle to late childhood between children who were neglected in infancy and non-neglected controls (Sheridan, Fox, Zeanah, McLaughlin, & Nelson III, 2012) and perhaps these persist into adulthood.

Although prior literature has implicated PTSD in understanding deficits in executive functioning in maltreated individuals, we did not find that PTSD acted as a mediator or moderator in these relationships. A number of possible reasons may explain the discrepancy. First, the design of our study allowed us to disentangle the contributions of these factors and, thus, to overcome some of the pitfalls of past research that confounded the effects of PTSD with the traumatic experience itself. Second, most of the prior work has not focused on the effects of child maltreatment but rather has examined the impact of other traumas. To our knowledge, only one previous study with young children has found that executive functioning was impaired specifically for neglected children who develop PTSD (De Bellis et al., 2009). Third, our findings may differ from earlier studies because of the different length of follow-up and developmental periods assessed. Fourth, PTSD symptoms may have subsided by the time of the neuropsychological assessment at approximate age 41, suggesting that it is only current PTSD that impacts neuropsychological deficits. Fifth, it is possible that PTSD acts on different parts of the prefrontal cortex that were not assessed by our measures. Non-verbal reasoning and executive functioning have both been linked to the dorsolateral prefrontal cortex (Kane & Engle, 2002; Wilson et al., 2011) and non-verbal reasoning has also been linked to rostrolateral prefrontal cortex (Ferrer et al., 2009), while studies of PTSD have implicated the medial prefrontal cortex regions (Elzinga & Bremner, 2002). Finally, it is important to bear in mind that most of the literature utilizes cross-sectional designs and ours is a 30-year longitudinal follow-up.

Despite the numerous strengths of the current study, limitations need to be acknowledged. The findings of the current study are based on cases of childhood abuse and neglect drawn from official court records and most likely represent the most extreme cases processed in the system (Groeneveld & Giovannoni, 1977). This means that these findings are not generalizable to unreported or unsubstantiated cases of child abuse and neglect (Widom, 1989b). Because these official cases are skewed toward the lower end of the socioeconomic spectrum, these findings cannot be generalized to abuse and neglect that occurs in middle- or upper- class children and their families. Consequences of childhood abuse and neglect for upper- or middle- class children may be different from children in the current study (Widom, 2000). The current findings also represent the experiences of children growing up in the late 1960s and early 1970s in the Midwest part of the United States. It is possible that children maltreated at a later time may manifest different consequences. Executive functioning is composed of multiple components and we have only assessed some of these aspects. In

addition, we did not have childhood and pre-maltreatment assessments of neuropsychological functioning and could not control for these in our analyses. Finally, our assessment of PTSD was performed prior to the assessment of executive functioning and it is possible that participants no longer had PTSD concurrent with executive functioning.

This study is the first prospective, longitudinal study to show that individuals with documented histories of childhood neglect exhibit deficits in executive functioning 30 years later, which are not explained by general intellectual functioning, PTSD, or concurrent depression or excessive alcohol use. Executive functioning and non-verbal reasoning are important for a range of attention, planning and organization and problem solving tasks that are an integral part of everyday living. Deficits in these areas may impair a person's quality of life and ability to achieve academically and engage in social interactions, among other skills. These results demonstrate another important negative long-term consequence of neglect and suggest the need for targeted efforts dedicated to interventions for neglected children.

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Table 1

Characteristics of the sample at two waves of the study (1898-1995 and 2003-2005)

INTERVIEW DATES	1989-1995	2003-2005
N	1196	792
Sex (% male)	51.3	46.9
White (%)	61.5	59.1
Black (%)	32.5	34.3
Other (%)	2.3	2.7
Hispanic (%)	3.8	3.9
Ethnicity (% White, non-Hispanic)	61.5	59.1
Abuse/neglect (%)	56.5	56.8
Physical abuse (%)	9.2	9.6
Neglect (%)	45.4	45.8
Sexual abuse (%)	8.0	7.5
Mean age at petition (SD)	6.3 (3.3)	6.24 (3.3)
Mean age at interview (SD)	29.2 (3.8)	41.2 (3.5)
IQ (M, SD)	37.0 (6.0) SS = 88.5	37.1 (6.09) SS = 88.5
PTSD (%, lifetime diagnosis)	26.3	28.9

Note: SS= standard score; there were no significant differences in sample characteristics across the two time points.

Table 2

Executive Functioning (Trail Making A and B and Matrix Reasoning Test Scores) for Child Abuse/Neglect and Control Groups in Middle Adulthood

	Control (N = 342)	**Abuse/Neglect (N = 450)**		**Neglect (N = 364)**		**Sexual Abuse (N = 60)**		**Physical Abuse (N = 77)**	
	M (SD)	**M (SD)**	**t (df)** ***Cohen's d***	**M (SD)**	**t (df)** ***Cohen's d***	**M (SD)**	**t (df)** ***Cohen's d***	**M (SD)**	**t (df)** ***Cohen's d***
Trail Making B	79.14 (41.23)	95.66 (50.94)	4.97 (768)*** .35	99.40 (52.23)	5.65(655)*** .43	88.84 (54.04)	1.30 (67) .23	81.25 (36.69)	.41(412) .05
Trail Making A	34.02 (15.67)	39.04 (20.41)	3.89 (780)*** .28	39.12 (20.94)	3.65 (655)*** .28	38.77 (20.34)	1.72 (72)† .29	38.00 (16.43)	1.96 (412)* .25
Matrix Reasoning	Raw Score 15.45 (5.67) SS = 8	Raw Score 13.22 (6.07) SS = 7	5.31 (757)*** .37	Raw Score 12.87 (5.98) SS = 7	5.89 (704)*** .44	Raw Score 14.37(6.69) SS = 8	1.17 (73) .18	Raw Score 13.71 (6.10) SS = 7	2.39 (417)* .30

Note: Asterisks indicate significant differences in a t-test comparing abuse/neglect (and specific types) to controls. Cohen's d = a measure of effect size; Trail Making A and B scores are seconds to completion and Matrix Reasoning scores represent the number of correctly completed items. SS= Standard Score

† $p <$ .10

* $p < 0.05$

*** $p < 0.001$

Table 3

Child Abuse/Neglect as a Predictor of Trail Making B Scores in Middle Adulthood (Betas)

	Child Abuse/Neglect				Neglect				Sexual Abuse				Physical Abuse			
Model	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Group	.19***	.11**	.12**	.11**	.23***	.15***	.15***	.14***	.06	.03	.03	.02	.07	.00	.01	−.00
White, not Hispanic	−.22***	−.17***	−.17***	−.17***	−.24***	−.18	−.18***	−.18***	−.22***	−.18***	−.18***	−.17**	−.21***	−.15**	−.15**	−.15**
Female	−.06	−.08*	−.08*	−.09**	−.04	−.07	−.07	−.08*	−.05	−.07	−.07	−.08	−.07	−.08	−.08	−.09
Age	.06	.09**	.09***	.09**	.11**	.14***	.14***	.13***	.02	.04	.04	.04	.04	.06	.06	.06
Age 29: IQ		−.29***	−.28***	−.28***		−.30***	−.30***	−.28***		−.22***	−.22***	−.22***		−.29***	−.29***	−.28***
Age 29: PTSD dx			.01	−.01			.01	−.01			.02	.00			−.02	−.04
Age 41: Depression				.11**				.10**				.07				.09
Age 41: Excessive alcohol				−.01				−.01				−.05				−.06
R²Δ	.09***	.07***	.00	.01**	.12***	.08***	.00	.01*	.05***	.05***	.00	.01	.05***	.08***	.00	.01
R²adjusted	.09***	.16***	.16***	.17***	.12***	.20***	.20***	.20***	.04***	.09***	.09***	.09***	.04***	.12***	.12**	.12***
N				754				674				388				404

Note: Four models were tested: (1) age, race, and sex (ARS); (2) ARS and IQ; (3) ARS, IQ, and past history of PTSD diagnosis; and (4) ARS, IQ, PTSD diagnosis, and depression and excessive alcohol consumption concurrent with the executive functioning assessment. PTSD Dx = lifetime DSM-III-R diagnosis at approximate age 29; Depression = number of CES-D symptoms; Excessive alcohol = alcohol consumption; Betas = standardized regression coefficients; *N*= number of participants; R^2 Δ = change in R^2; R^2 *adjusted*= adjusted squared multiple correlation coefficient

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

Table 4

Child Abuse/Neglect as a Predictor of Matrix Reasoning Scores in Middle Adulthood (Betas)

	Child Abuse/Neglect				Neglect				Sexual Abuse				Physical Abuse			
Model	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Group	−.18***	−.08*	−.08*	−.08*	−.21***	−.11**	−.11**	−.11**	−.05	.00	.01	.02	−.11*	−.02	−.02	−.02
White, not Hispanic	−.13***	.06	.06	.06	.12**	.05	.07	.06	.08	.02	.02	.01	.07	−.01	−.01	−.01
Female	.00	.02	.03	.04	−.00	.02	.03	.04	.06	.09*	.10*	.12*	.10*	.12**	.12*	.12*
Age	−.13	−.16***	−.16	−.16***	−.15***	−.17***	−.18***	−.17***	−.19***	−.21***	−.21***	−.21***	−.14**	−.17***	−.17***	−.17***
Age 29: IQ		.39***	.39***	.37***		.37***	.37**	.36***		.36***	.36***	.35***		.39***	.39***	.38***
Age 29: PTSD dx			−.01	.01			−.03	−.01			−.05	−.03			.00	.02
Age 41: Depression				−.08*				.07*				−.09				−.07
Age 41: Excessive alcohol				.03				.03				.06				.00
R²Δ	.07***	.14***	.00	.01*	.08***	.12***	.00	.01	.05***	.12***	.00	.01	.04**	.14***	.00	.01
R²adjusted	.07***	.20***	.20***	.20***	.08***	.20***	.20***	.20***	.05***	.17***	.17***	.17***	.04***	.17***	.17***	.17***
N				775				692				392				407

Note: Four models were tested: (1) age, race, and sex (ARS); (2) ARS and IQ; (3) ARS, IQ, and past history of PTSD diagnosis; and (4) ARS, IQ, PTSD diagnosis, and depression and excessive alcohol consumption concurrent with the executive functioning assessment. PTSD Dx = lifetime DSM-III-R diagnosis at approximate age 29; Depression = number of CES-D symptoms; Excessive alcohol = alcohol consumption; Betas = standardized regression coefficients; *N*= number of participants; R^2 Δ = change in R^2; R^2 *adjusted*= adjusted squared multiple correlation coefficient

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

Table 5

Child Abuse/Neglect as a Predictor of Trail Making A Test Scores in Middle Adulthood (Betas)

	Child Abuse/Neglect				Neglect				Sexual Abuse				Physical Abuse			
Model	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Group	.14***	.07*	.06	.06	.14***	.07	.06	.05	.11*	.09	.08	.07	.12*	.08	.08	.07
White, Not Hispanic	.17***	−.12**	−.12***	−.13***	−.16***	−.11**	−.12**	−.12**	−.16**	−.14**	−.14**	−.13**	−.12*	−.08	−.08	−.08
Female	−.07*	−.09*	−.10**	−.11**	−.08*	−.10**	−.12**	−.12**	−.10*	−.12*	−.12*	−.13*	−.13**	−.14**	−.15*	−.15**
Age	.09**	.12**	.12**	.12**	.11**	.13***	.13***	.13***	.13*	.14**	.14**	.14**	.11*	.12*	.12*	.12*
Age 29: IQ		−.25***	−.25***	−.24***		−.26***	−.26***	−.25***		−.18***	−.17**	−.16**		−.15**	−.15**	−.14**
Age 29: PTSD dx			.08*	.06			.07*	.07			.05	.03			.04	.02
Age 41: Depression				.06				.03				.10				.08
Age 41: Excessive alcohol				.01				.00				−.00				.00
R*²*Δ	.06***	.05***	.01*	.00	.06***	.06***	.01*	.00	.07***	.03***	.00	.01	.05***	.02**	.00	.01
R*²*adjusted	.06***	.11***	.12***	.12***	.06***	.12***	.12***	.12***	.06***	.08***	.08***	.09***	.04***	.06***	.06***	.07***
N				765				682				391				403

Note: Four models were tested: (1) age, race, and sex (ARS); (2) ARS and IQ; (3) ARS, IQ, and past history of PTSD diagnosis; and (4) ARS, IQ, PTSD diagnosis, and depression and excessive alcohol consumption concurrent with the executive functioning assessment. PTSD Dx = lifetime DSM-III-R diagnosis at approximate age 29; Depression = number of CES-D symptoms; Excessive alcohol = alcohol consumption; Betas = standardized regression coefficients; *N*= number of participants; R^2 *Δ* = change in R^2; R^2 *adjusted*= adjusted squared multiple correlation coefficient

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$