Association of Early Life Stressors with Deficits in Child and Adolescent Cognitive Functioning

Emily M. Deming
West Virginia University, emdeming@mix.wvu.edu

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Association of Early Life Stressors with Deficits in Child and Adolescent Cognitive Functioning

Emily Deming

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Elisa Krackow, Ph.D., Chair
Marissa Carey, Ph.D.
Mariya Cherkasova, Ph.D.
Cheryl McNeil, Ph.D.
Carrie Rishel, Ph.D.
Department of Psychology

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Abstract

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Emily Deming

The purpose of this study was to determine whether the ACEs questionnaire could be a viable screener tool for identifying children in need of neuropsychological testing. This study consisted of a sample of child participants aged 8-17 years (N=53) who were divided into a no ACEs group or the ACEs group (1 or more ACEs) depending on parental responses to the ACEs questionnaire. Participants completed a series of virtual neuropsychological tests that assessed overall neurocognitive functioning, memory, and attention. No significant differences between the no ACEs group and the ACEs group in performance of the overall Neurocognitive Index, Composite Memory Index, or Complex Attention Index emerged. While no significant differences were found in this study, the demographic make-up of the sample could in part explain the absence of significant findings. The sample for this study included highly educated parents who resided in a higher SES bracket. These and other limitations are discussed. While this study did have limitations, several future directions were identified that would strengthen this area of research.
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Introduction

Early Life Stressors are characterized as a single event or multiple events that cause stress beyond the child’s ability to cope with the stressor and thereby create a period of prolonged stress (Brown et al., 2009). While the term itself has the word “early” in it, researchers use the term to refer to stress that can be experienced from infancy through the age of 17 (Brown et al., 2009). Throughout this paper the term, “early life stressors” “life stressors in childhood” and “adverse childhood experiences” will be used interchangeably to denote the experience of life stressors experienced from infancy through age 17. The most common early life stressors are abuse, neglect, dysfunction in the home (e.g., witnessing domestic violence, parental separation/divorce), poverty, witnessing drug use, parental illness or death, and being affected by a disaster (Brown et al., 2009). A study of adults’ retrospective reports of rates of early life stressors found that in the United States approximately 65% of adults experienced one or more early life stressors as a child and approximately 12.5% of adults experienced two or more early life stressors during childhood (Middlebrooks & Audage, 2008). Currently it is estimated that 46% of the 34 million US children (under the age of 18) experienced at least one early life stressor and over 20% experienced at least two early life stressors (Blair, 2017).

Adverse Childhood Experiences (ACEs) Questionnaire

The Adverse Childhood Experiences (ACEs) questionnaire was developed by the Center for Disease Control (CDC) and Kaiser Permanente as a measure to rapidly assess childhood adverse experiences during the first 17 years of life (i.e., experiencing maltreatment, witnessing violence, having a family member attempt or commit suicide, parental divorce, drug use within the home, and imprisonment of a close family member). It is now seen as the gold standard
assessment measure (Felitti et al., 1998). The ACEs questionnaire has been shown to be a psychometrically and ecologically valid measure of childhood adverse experiences in US and international populations (Cheong et al., 2017; Wingenfeld et al., 2010). Research based in Ireland has also shown that the endorsement of ACEs on the ACEs questionnaire is a reliable predictor of depression in adulthood (Cheong et al., 2017). More than half of the 13,000+ adult participants in the initial ACEs questionnaire validation study endorsed experiencing at least one ACE and one-quarter experienced two or more ACEs (Felitti et al., 1998). Experiencing ACEs in childhood correlates long-term with engagement in risky sexual behavior, drug abuse, smoking, obesity, physical inactivity, depression, anxiety, suicidality, and early death due to other factors (Felitti et al., 1998).

The original ACEs questionnaire and various adapted versions can be used as screening tools in treatment settings. Screening measures are commonly used tools for instilling preventative practices and early interventions. The success of other screening measures has helped to bolster the rationale for utilizing the ACEs questionnaire as a screening process (Finkelhor, 2017). The experience of early life stressors (ACEs) has been shown to be a reliable predictor of potential negative health outcomes, including increased likelihood of being diagnosed with cancer, chronic lung disease, heart disease, drug/alcohol abuse, and mental health concerns (Felitti et al., 1998). Based on data such as these, policy statements of various healthcare organizations, the American Academy of Pediatrics (Garner et al., 2011) and the American Heart Association (2019) endorse the need for professionals to screen children for ACEs. By identifying ACEs early on, medical professionals can help to establish referral networks and to intervene before the risk of a negative health outcome becomes a reality (Bethell et al., 2017; Gerlach, 2017). The American Heart Association (2019) policy statement includes a
recommendation for regular ACEs screenings within the school system in order to directly address concerns of lower academic achievement, truancy, and dropout for those children who have experienced ACEs.

In addition to policy statements by leading healthcare organizations, varied academic research has been conducted to assess the use of the ACEs questionnaire in clinical settings. Various reviews indicate that the ACEs questionnaire is often used in pediatric care settings and primary care settings (Ereyi-Osas, Racine, & Madigan, 2020). Having parents complete the ACEs questionnaire led to better provider patient rapport, including serving as a springboard for discussion and ensuing support when ACEs were endorsed (Ereyi-Osas, Racine, & Madigan, 2020). The inclusion of the questionnaire was not perceived to interfere with the visit based on clinician nor parent report (Glowa, Olson, & Johnson, 2016).

Based on the data reported in the literature, this author will make the case for conducting a study assessing ACEs (via the ACEs questionnaire) and neurocognitive functioning. If responses on the ACEs questionnaire are found to be associated with neurocognitive deficits, the ACEs questionnaire could be used to inform medical and mental health personnel as to whether youth should be referred for neurocognitive screening. In doing so, the author will describe how the experience of early life stressors is related to neurocognitive functioning through the lens of life stressors and brain structure/brain functioning, life stressors and cognitive functioning, including the specific ACEs listed on the ACEs questionnaire.

**Life Stressors and Brain Functioning**

Exposure to early life stress can have particular effects on the brain (Brenhouse & Andersen, 2011; Perry, 2009). As the brain’s neural networks develop, the overall developmental process shifts in order to optimize the brain’s functioning for the environment it is in. This shift
also sometimes has negative effects (Perry, 2009). When a person experiences stress, hormones are released in the body and an inflammatory process is initiated in order to help protect the body (Brenhouse & Andersen, 2011; Perry, 2009). If the person undergoes long-term exposure to stress, these inflammatory and hormonal stress responses can affect the brain and body, by causing dysfunction in the normal brain processes and a loss of function or structure of brain regions (Brenhouse & Andersen, 2011). For example, youth who have experienced early life stressors do not have significantly smaller hippocampal volume when compared to a healthy control sample, but differences do emerge when looking at an adult sample (Teicher et al., 2003). These results suggest that there can be delayed effects of early life stressors, including effects on brain structures. In addition to changes in hippocampal volume under chronic stress, more changes in neuro-circuitry occur, most notably in the prefrontal cortex. For example, children who experienced early life stress had weaker dendritic structures (Chen & Baram, 2016). The implications for this are that the system of dendrites in the hippocampal structures undergoes neuronal death and the brain prunes areas that are not being used. The prefrontal cortex is not functioning in a way that is to be expected, which may limit communication between the prefrontal cortex and other areas of the brain (e.g., hippocampus, medial temporal lobe) during the developmental period of middle childhood and early adolescence, when said communication is expected to increase dramatically (Ghetti & Bunge, 2012; Willoughby et al., 2012).

Knowledge of how the brain is structurally changing in response to early life stressors is important, but it is equally important to understand the mechanism of action as to why the brain structures are being affected. Chronic exposure to stress leads to a hormonal response in the body and the brain. Long-term exposure to these hormones generates structural changes in the brain, as well as can lead to neuronal death, lack of activation in brain regions (e.g., hippocampus,
prefrontal cortex), and a reduction in brain volume (Anisman et al., 1998; Brenhouse & Andersen, 2001). It is important to note that these changes may not be observable during childhood or adolescence, but can be observed in adulthood when brain maturation is complete.

**Memory**

A study that utilized an adult sample (ages 20 to 50 years) assessed participant exposure to early life stressors and how that exposure affected their brain functioning and structure long term (Saleh et al., 2016). Participants completed an early life stressors questionnaire that inquired about exposure to traumatic instances in the first 17 years of their life (Saleh et al., 2016). Adults who had experienced emotional abuse, sexual abuse, or severe familial dysfunction and had experienced depression had decreased hippocampal volume compared to a control sample who did not experience the aforementioned stressors (Saleh et al., 2016). The hippocampus is involved in encoding and storing episodic autobiographical memories, processes that are necessary for event recall (Burgess et al., 2002). When the hippocampus is compromised, a person’s ability to encode, store, and retrieve information in long-term memory may be reduced.

When rodents were exposed to stressful situations early in their life span (post-natal weeks 1-3), stress slowed the growth of the hippocampus and atrophied the hippocampus, as discovered in post-mortem brain analysis (Kosten et al., 2012). Also, rat pups who were exposed to chronic early life stress had smaller hippocampal volume compared to rat pups who were not exposed to chronic early life stress (Kosten et al., 2012). It is important to note that a rat pup’s development is shorter compared to a human’s, but the main point is that when stress is experienced during key developmental periods, it can have major negative effects on the brain as it is developing (Kosten et al., 2012).
Exposure to early life stressors in humans shows similar effects on memory impairment. Farah et al. (2006) compared several areas of cognitive functioning in children from a low socioeconomic status group (mean age 11.7 years) and a middle socioeconomic status group (mean age 11.7 years) and found that children in the low socioeconomic status group were more likely to exhibit deficits in memory. Further FMRI procedures identified impairments in the medial temporal lobe (Farah et al., 2006) which houses the hippocampus and associated areas (Squire & Zola-Morgan, 1991). The area of the medial temporal lobe is important because it is associated with a human’s ability to consolidate information into long-term memory and provides a connecting site for all areas associated with memory necessary to form a more complete memory (Squire & Zola-Morgan, 1991).

Executive functioning (e.g., sustained attention, inhibitory control, cognitive flexibility)

Executive functioning skills are important because they allow a child to succeed in a school setting where they are required to focus for extended periods of time, interact with peers and teachers appropriately, and appropriately react to a plethora of stimuli. Executive functioning skills are also important for day-to-day, minute-to-minute skills, such as when listening to a parent, completing basic tasks, and generally responding to stimuli in the environment. Sustained attention is one component of executive functioning skills, defined as an individual’s ability to maintain engagement with a specific target for an extended period of time (Fortenbaugh et al., 2017). Inhibitory control is defined as the ability to prevent an action that is not an appropriate response to the stimuli; this is most commonly described as impulsivity (Roberts et al., 2011). Another component of executive functioning is cognitive flexibility; this is defined as the ability to switch cognitive strategies in order to better adapt to changing stimuli in the environment (Dennis & Vander Wal, 2010). These components are all used at varying times and rates when
executive functioning skills are being used. Youth who are chronically exposed to early life stressors often experience increased psychomotor activity, behavioral impulsivity, and hyperarousal related to an over firing of their hyperarousal system in response to the chronic stress (Perry et al., 1995).

A study that involved a sample of children who were housed in orphanages internationally between 4 and 34 months of age and subsequently adopted between 16 months and 36 months, assessed how their exposure to early life stressors altered the functioning of their prefrontal cortices compared to a control group of children who were not placed in orphanages (Hostinar et al., 2012). At the time of the study, the children were on average were 3 years of age (Hostinar et al., 2012). In order to assess executive functioning, the study utilized several different neuropsychological tests including the Dimensional Change Card Sort Test (Zelazo, 2006) (cognitive flexibility), Spin the Pots task (Hughes & Ensor, 2005) (working memory), Delay of Gratification task (Mischel et al., 1989) (inhibitory control), and an abbreviated IQ battery adapted from the Stanford-Binet Intelligence Scales (fifth edition) (Hostinar et al., 2012). It was discovered that the children who were adopted had significant reductions in their cognitive functioning (e.g., higher order functioning, problem solving) related to the prefrontal cortex and executive functioning when compared to the control group (Hostinar et al., 2012). It is important to note in this sample that IQ score was not impacted but specific measures of executive functioning showed impairment (Hostinar et al., 2012).

The effects of early life stressors on executive functioning can also be found in children who grew up in lower SES families (Hackman et al., 2015). The closer the gap between the family’s total income and their closeness to the poverty threshold has been used as the marker for current and past exposure to early life stressors (Hackman et al., 2015). Hackman et al. (2015)
found that children from lower family incomes and children with mothers who completed lower levels of education performed lower on tasks that assess executive functioning. Specifically, in order to assess executive functioning in children aged 54 months, grade 1 and grade 3 (Hackman et al., 2015), researchers administered the Memory of Sentences from the Woodcock-Johnson Test of Cognitive Abilities (working memory) (Woodcock, 1990; Woodcock & Johnson, 1989). In grades 1, 3, and 5, The Towers of Hanoi (Welsh et al., 1990; Welsh, 1991) task was also administered as a measure of executive functioning (planning and problem-solving). The effects of lower socioeconomic status were not only contained to early childhood, but they persisted through the fifth grade (Hackman et al., 2015). Executive functioning skills that are affected by socioeconomic status and maternal education play an important role in children’s educational success as well as social/emotional development (Hackman et al., 2015).

Evidence for deficits in executive functioning has also been shown in rodent studies where exposure to early life stressors can be controlled by the researchers and thus the relationship between early life stressors and executive functioning can be more clearly examined. The previously described study by Kosten and colleagues (2012) also showed that when rat pups experienced stress early in life, the size of the prefrontal cortex was smaller when compared to the prefrontal cortices of a no-early-life-stress control group. When the prefrontal cortex is affected, there can also be problems with sustained attention, cognitive flexibility, higher order functioning, and inhibitory control, all of which are subsumed under executive functioning.

The work conducted in rodent populations has been expanded to show that the findings can be translated to a human population. Children who experienced early life stressors often have more difficulty engaging in inhibitory control tasks, planning for long-term tasks, as well as show reduced volume in the prefrontal cortex (Pechtel & Pizzagalli, 2010). Adults who
experienced emotional abuse, sexual abuse, or severe familial dysfunction in their first 17 years of life displayed slower processing speeds as well as problems engaging in working memory tasks (Saleh et al., 2016). The common thread across these pieces of work is that changes in the structure of the brain led to the above-described negative outcomes that persisted long beyond the immediate stressor.

**Brain Development during Middle Childhood and Early Adolescence**

The period of middle childhood and early adolescence involves a great deal of development in various brain structures (Mah & Ford-Jones, 2012). Myelination, allows for faster synaptic transmission and more effective communication between the two hemispheres (Mah & Ford-Jones, 2012). This increase allows a child to more effectively manage multiple stimuli in the environment and to respond more efficiently to what happens in the environment increases during middle childhood (Mah & Ford-Jones, 2012). Additionally, during these periods of development there are changes in brain structures that are relevant to cognitive flexibility (i.e., attending to stimuli in the environment and processing complex thoughts and actions) (Mah & Ford-Jones, 2012). Additionally, the brain builds a stronger feedback loop between the forebrain and midbrain which generate the ability to regulate thoughts and actions in increasingly complex interactions with the environment (Mah & Ford-Jones, 2012). This maturational process can help youth manage stimuli in the classroom, at home, or during interpersonal interactions (Mah & Ford-Jones, 2012).

During middle childhood the volume of the brain is reaching its peak; the volume of gray matter has reached its peak; and there is a continued increase in the volume and structure of white matter (DelGiudice, 2018). As the brain is reaching its peak volume, the individual parts of the brain are increasing in capacity and functioning (DelGiudice, 2018). As sections of the brain
develop, the child begins to show an increase in specific areas of cognitive functioning that allow them to adapt and survive in their environment (DelGiudice, 2018). As a child progresses through the developmental phase of middle childhood, they typically show increases in problem solving skills, inhibition, attention, planning, working memory, and understanding multiple perspectives (DelGiudice, 2018).

Middle childhood is the key period of development for memory (Ghetti & Bunge, 2012), including semantic and episodic memory. Systems for communication between the prefrontal cortex and medial temporal lobe (most notably the hippocampus) exist in early childhood, but the binding connections that are not frequently used are not strengthened, and unused synaptic connections are not pruned until middle childhood (Ghetti & Bunge, 2012). The connections between the prefrontal cortex and the medial temporal lobe are strengthened, such that communication between areas becomes more efficient, thus leading to faster process and an increase in capacity for episodic memory (Ghetti & Bunge, 2012), as well as an increase in abilities necessary to function in daily life, such as those related to executive functioning.

Brain development does not cease after middle childhood; in early adolescence there is still significant change in the structure of the brain, as well as increases in cognitive capacity (Konrad et al., 2013). Synaptic pruning and refinement of activation patterns allow for more efficient communication between different areas of the brain, which allow for an increase in executive functioning skills, episodic memory, and semantic memory. The synaptic pruning process continues as the brain refines the connections necessary to create a more efficient processes (Konrad et al., 2013). The strengthening of these connections allows for increased use of executive functioning abilities to regulate an adolescents’ thoughts and emotions. As an adolescent’s neuro-circuitry continues to strengthen, there is an increase in the person’s ability to
multi-task, problem solve, and to process increasingly complex stimuli (i.e., managing visual, auditory, and interpersonal pieces of stimuli in the environment) (Arain et al., 2013).

During early adolescence there are changes to memory capabilities, in addition to the changes seen in executive functioning skills. There are significant increases in semantic and episodic memory between the ages of 8 years and 16 years through the development of the hippocampus and frontal lobe (Willoughby et al., 2012). The continuous strengthening of connections and synaptic pruning allows for the refinement of the neural processes and thus an increase in cognitive abilities is afforded.

In summary, as a person progresses through the developmental periods of middle childhood and early adolescence, there are many important pieces of brain functioning that are affected. There are significant increases in communication between the prefrontal cortex and areas of the brain associated with cognitive (i.e., memory) processes. During the aforementioned developmental periods, there are numerous changes in the brain, both functional and structural, that can lead to major changes in overall cognitive functioning as well as increases in specific skills. The impact of particular life stressors on cognitive functioning will now be discussed. These life stressors map onto items on the ACEs questionnaire.

**Life Stressors Assessed by the ACEs Questionnaire (Completed by caregiver) and Their Associations with Cognitive Functioning**

**Data for Cognitive Effects**

In this section, the ACEs item will appear verbatim and then the data regarding the presence of absence of that ACEs item on cognitive effects will be presented. See Table 9 for a summary of each article included in this review of cognitive effects associated with particular items on the ACEs questionnaire.
“Your child’s parents or guardians were separated or divorced” (Burke Harris & Renschler, 2015)

A group of children from single parent homes (divorced or separated in first 3 years of life) and a group of children from two parent homes were assessed using the Bayley Scale of Mental Development (Bayley, 1969) (administered at 15 months and 24 months) and the Reynell Development of Language Scales (Reynell, 1991) (administered at 36 months) (Clarke-Stewart et al., 2000). There were no significant differences between the two groups on either outcome measure when maternal education and family income were controlled (Clarke-Stewart et al., 2000). There were significant differences between the groups on original analyses when no variables were controlled (Clarke-Stewart et al., 2000).

Another study by Poehlmann and Fiese (1994) assessed cognitive functioning in a group of toddlers aged 18 to 41 months, from either single, divorced parent homes or from 2 parent homes. Cognitive functioning was assessed at a single time point using the Bayley Scale of Mental Development (Bayley, 1969) (overall cognitive functioning score) and the Stanford-Binet Scales (Terman & Merrill, 1960) (IQ score) (Poehlmann & Fiese, 1994). There were no significant differences between the two groups for neither the Bayley Scale of Mental Development nor the Stanford-Binet scales, but an important note is that a significant amount of variance in the assessment scores between the two groups can be attributed to lack of stimulation in the single parent homes (Poehlmann & Fiese, 1994).

In summary, prior research has shown that when divorce/separation is the main variable of focus, there are no significant differences in cognitive functioning between children from divorced households and children from intact households. Significant differences only appeared when other demographic factors were not accounted for, thus leading to the notion that
demographic factors play a greater role in deficits in cognitive functioning than does divorce/separation.

“Your child lived with a household member who served time in jail or prison” (Burke Harris & Renschler, 2015).

Poehlmann (2005) utilized a sample of children aged 2-to-7-years who had mothers who had been incarcerated for at least 2 months and assessed their cognitive functioning using the Full-Scale IQ score from the Stanford-Binet Intelligence Scale (Thorndike et al., 1986) (Poehlmann, 2005). This study did not include a control group. Instead, the scores of the children whose mothers were incarcerated were compared to the standardized norms of the Stanford-Binet. Children whose mothers were incarcerated showed significantly lower Full-Scale IQ scores and showed increased risk for negative developmental outcomes associated with caregiver sociodemographic factors (i.e., caregiver education, caregiver drug use, caregiver relationship statues, premature birth) (Poehlmann, 2005).

Johnson and Easterling (2012) reviewed several studies in an attempt to better understand how parental incarceration affects the child who is left behind. According to Johnson and Easterling (2012), parental incarceration can be associated with an increased risk for disorders in their offspring (i.e., attention disorders and impulse control disorders) that are directly linked to executive functioning skills compared to children with similar demographic factors whose parents were not incarcerated. This may be due to changes in the environment related to the caregiver’s incarceration, such as changes in the child’s primary caregiver (Johnson & Easterling, 2012).

In summary, parental incarceration has been shown to be associated with deficits in specific areas of cognition, such as executive functioning and intelligence.
“Your child saw or heard household members hurt or threaten to hurt each other” (Burke Harris & Renschler, 2015)

A study of 4-to-13-year-olds, including one group who had witnessed domestic violence and a group of children who had not witnessed domestic violence, partook in cognitive functioning assessment procedures that included the Peabody Picture Vocabulary Test (PPVT) (Dunn, 1965) (receptive language), Santostefano’s Leveling/Sharpening Shootout Test (Santostefano & Rieder, 1984) (assimilation of memories and attention), and a theory of mind task (Perner et al., 1987; Rossman, 1998). The Leveling test assesses a child’s ability to narrate the high points of a story and fill in missing information with details that are consistent and believable, when recounting a story that they construct from pictures. Children who had witnessed domestic violence had significantly lower scores on the PPVT and the theory of mind task and had significantly higher scores on the leveling task (Rossman, 1998).

A study by Huth-Bocks and colleagues (2001) studied a sample of children, aged 3-5 years, then split that sample into two groups (had witnessed domestic violence and had not witnessed domestic violence) in order to assess their cognitive functioning using the Peabody Picture Vocabulary Test-Revised (PPVT-R) (Dunn & Dunn, 1981) (receptive language) and the block design subtest from the Wechsler Preschool & Primary Scale of Intelligence (WPPSI-R) (Wechsler, 1989) (visuospatial reasoning) (Huth-Bocks et al., 2001). Children who witnessed domestic violence had had significantly lower PPVT-R scores, even when SES and child abuse history had been controlled (Huth-Bocks et al., 2001). There were no significant differences in scores between the two groups for the WPPSI-R block design subtest (Huth-Bocks et al., 2001).

These findings were corroborated in a sample of children who witnessed intimate partner violence (Samuelson et al., 2010). All children in the sample, regardless of presence of PTSD
symptomology, scored in the below average range compared to normative data in measures of executive functioning, attention, and intellectual ability (Samuelson et al., 2010).

In summary, the results from these three studies show a connection between witnessing domestic violence has a distinct negative impact on a child’s cognitive functioning, more specifically on a child’s verbal ability, theory of mind ability, and visuospatial reasoning.

“Your child often saw or heard violence in the neighborhood or in her/his school neighborhood” (Burke Harris & Renschler, 2015)

Sharkey (2010) studied a sample of children, aged 5-17 years, recruited for a project on human development in neighborhoods that surround Chicago. Two groups of children were assessed after a local homicide took place (one from the neighborhood it occurred in and one form a separate neighborhood where no homicide had taken place) at the following intervals: 4 days after, 7 days after, 10 days after, 14 days after, and 28 days after (Sharkey, 2010). Cognitive functioning was assessed at the last interval using the following tests WISC-R (intelligence) (Wechsler, 1974), Woodcock-Johnson Letter Word Task (reading), and Woodcock-Johnson Applied Problems (mathematics and problem solving) (Sharkey, 2010). Children who had exposure of any kind to the homicide (e.g., saw the violence, heard the violence, heard people talking about the violent act) performed worse on all the cognitive tests than those who did not have exposure to the homicide (Sharkey, 2010).

In summary, witnessing or being exposed to violence in the neighborhood can be associated with significant deficits in broad cognitive measures of child’s intelligence.

“A household member swore at, insulted, humiliated, or put down your child in a way that scared your child OR a household member acted in a way that made your child afraid that s/she might be physically hurt” and “Someone pushed, grabbed, slapped, or threw something at
your child OR your child was hit so hard that your child was injured or had marks” (Burke Harris & Renschler, 2015)

Mills et al. (2010) studied a sample of children that was split into two groups, abused and/or neglected group and a control group. The sample was recruited over a 2-year period during routine medical visits while the mother was pregnant (Mills et al., 2010). Cognitive functioning was assessed at age 14 using the Raven’s Standard Progressive Matrices (RSPM), a non-verbal measure of fluid intelligence (Mills et al., 2010). Children who experienced abuse and/or neglect had significantly lower scores on the RSPM than their counterparts in the control group who had not experienced abuse and/or neglect (Mills et al., 2010).

The Mills et al. (2010) study focused on cognitive functioning during childhood, but is also important to understand the long-term impacts of abuse on the person through adulthood. A study by Gould et al. (2012) helped to develop a clearer picture about whether and how abuse experienced during childhood affects a person’s cognitive abilities in adulthood. The authors split a sample of adults, aged 18-54 years into an abuse/neglect group and a no abuse/neglect control group (Gould et al., 2012). Cognitive functioning was assessed at a single time point using the Cambridge Neuropsychological Automated Testing Battery (Sahakian & Owen, 1992) (CNATB) (Gould et al., 2012). The CNATB encompasses several domains of cognitive functioning such as psychomotor coordination, motor speed, reasoning and planning abilities, memory, and attention (Gould et al., 2012). While there were no significant differences between the two groups, there were significant associations between abuse/neglect and lower scores on the neurocognitive testing. For those who had experienced abuse/neglect in childhood, there was a negative correlation with scores on delayed matching to sample and Intra-Extra Dimensional Set Shift (Gould et al., 2012). These results varied depending on type of abuse experienced
For those who had experienced emotional/verbal abuse, there was a negative correlation with the Stockings of Cambridge task and Delayed Matching to Sample task (Gould et al., 2012). For those who had experienced physical forms of abuse, there was a negative correlation with Intra-Extra Dimensional Set Shift task, Stockings of Cambridge task, and the Rapid Visual Processing task (Gould et al., 2012). Overall the experience of abuse was associated with more negative scores on the measures listed above when correlations were conducted with the control participants (Gould et al., 2012).

In summary, the previously described studies showed that adults who had experienced abuse/neglect as children had significantly more deficits in cognitive functioning compared to the control groups. The overall impact of abuse/neglect is not uniform; the different forms of abuse affect different aspects of cognition.

“Someone touched your child’s private parts or asked your child to touch their private parts in a sexual way” (Burke Harris & Renschler, 2015)

The study by Gould et al. (2012) studied a subset of adults (18-54 years) by comparing those who had experienced sexual abuse during childhood to a control group who had not experienced sexual abuse during childhood. The results from the CNATB showed experiencing sexual abuse during childhood negatively correlated with scores on the Intra-Extra Dimensional Set Shift task and the Spatial Working Memory Task (Gould et al., 2012).

Navalta et al. (2006) also assessed the impact of childhood sexual abuse on adulthood cognitive functioning. This study assessed a sample of 26 college-aged women who had experienced repeated sexual abuse during childhood and a control group of 19 college-aged women who had no abuse history (Navalta et al., 2006). Their cognitive functioning was assessed at a single time point using the Memory Assessment Scale (Williams, 1991),
Continuous Performance Task (Mezzacapa et al., 2001) (sustained attention and inhibition/disinhibition), and the self-report Scholastic Aptitude Test (Cassady, 2001) (participant self-assessed verbal and mathematical reasoning skills) (Navalta et al., 2006). There were no significant differences between the two groups on the verbal and short term memory scales, but those who had experienced sexual abuse had significantly lower scores on the visual and overall memory scale scores (Navalta et al., 2006). There were no significant differences on the continuous performance task but the abused group had more variability in their reaction times than did the control group (Navalta et al., 2006).

In summary, individuals who have experienced sexual abuse during childhood exhibit significant deficits in memory, reasoning and planning abilities, and aspects of attention.

“More than once, your child went without food, clothing, a place to live, or had no one to protect her/him” (Burke Harris & Renschler, 2015)

This item can be conceptualized as measuring neglect but can also be construed as experiencing poverty or economic hardship.

The previously mentioned Gould et al. (2012) study that assessed cognitive functioning of adults (18-54 years) who had experienced abuse/neglect included a group of individuals who experienced neglect during childhood. Scores on the Delayed Matching to Sample task and Intra-Extra Dimensional Set Shift task were negatively correlated with depression for those in the non-abuse/neglect sample (Gould et al., 2012). Overall the experience of neglect was associated with more negative scores on the measures listed above than when correlations were conducted with the control participants.

Research has also been conducted to assess how neglect can affect a child’s cognitive functioning during childhood. The study by Mills et al. (2010) utilized a birth cohort of
participants recruited from the same hospital over a two-year period and assessed them at age 14. While they did not separate the groups into abuse only, neglect only, and abuse and neglect, those who had experienced abuse and/or neglect had significantly lower scores on the Raven’s Standard Progressive Matrices (Raven et al., 1998) (non-verbal measure of fluid intelligence) (Mills et al., 2010).

Beers and De Bellis (2002) studied a sample of children that were neglected and had been diagnosed with post-traumatic stress disorder. Cognitive functioning was assessed using the following measures: Clinical Evaluation of Language Fundamental Concepts and Directions (Spreen & Strauss, 1998) (receptive and expressive language), WISC-III Vocabulary (Woogler, 2001) (verbal intelligence), Stroop Color and Word Test (Spreen & Strauss, 1998) (cognitive interference), Digit Vigilance Test (Lewis & Rennick, 1979) (sustained attention and psychomotor speed), Wisconsin Card Sorting Test (Spreen & Strauss, 1998) (cognitive flexibility), Controlled Oral Word Association Test (Benton, Hamsher, and Sivan, 1994) (verbal fluency), Trail Making Test (Spreen & Strauss, 1998) (visual attention and task shifting), California Verbal Learning Test (Spreen & Strauss, 1998) (verbal learning), Rey-Osterrieth Complex Figure (Spreen & Strauss, 1998) (visuospatial ability, memory, attention, and planning), Money Road Map (Money, Alexander, and Walker, 1965) (left-right discrimination), WISC-III Block Design (visuospatial ability), Object Assembly (visual analysis), Similarities (verbal abstract reasoning), and Coding (visual motor skills), Judgement of Line Orientation (Benton et al., 1983) (visuospatial skills), and Grooved Pegboard (Spreen & Strauss, 1998) (manipulative dexterity) (Beers & De Bellis, 2002). The children in the neglected group had significant deficits in the domains of attention and executive functioning (Beers & De Bellis, 2002). Those in the neglected group had significantly more difficulty with sustained attention
and made more errors on tasks that assessed functioning of the frontal lobe (Beers & De Bellis, 2002).

Previous research has shown that children from lower socioeconomic status exhibit lower levels of executive functioning skills and inversely, the presence of high stress, possibly brought about by lower SES, can undermine the development of executive functioning skills (Zelazo et al., 2018). Higher levels of stress due to food insecurity, housing insecurity, or even poverty can be related to the deficit of executive functioning skills necessary to thrive in a home and school environment (Hackman & Farah, 2009; Zelazo et al., 2018).

In summary, children and adults who have experienced neglect or poverty during childhood exhibit deficits in areas of cognitive functioning (e.g., attention, executive functioning) when compared to control samples.

“Your child often felt unsupported, unloved, and/or unprotected” (Burke Harris & Renschler, 2015)

Jacobsen et al. (1994) studied a group of 85 Icelandic children to better understand how attachment style was related to cognitive functioning. The children in this study were assessed at ages 7, 9, 12, 15, and 17 for attachment style (age 7 only), self-confidence (age 7 only), and cognitive functioning (all ages) (Jacobsen et al., 1994). This study assessed cognitive functioning through a variety Piagetian and developmental techniques, self-confidence through a questionnaire, and attachment style through a separation story task (Jacobsen et al., 1994). The results showed that children with secure attachment had better overall cognitive scores through childhood and adolescence compared to children with insecure-avoidant attachment (Jacobsen et al., 1994). Children with insecure-disorganized attachment had more pronounced difficulties with deductive reasoning tasks compared to children with secure attachment (Jacobsen et al.,
1994). Upon further assessment it was found that the child’s reported self-confidence significantly mediated the relationship between attachment style and cognitive functioning (Jacobsen et al., 1994).

Another study that focused on how attachment style can effect a child’s executive functioning included the children who were assessed for attachment style (using Strange Situation Procedure) during infancy and their executive functioning was assessed using Running Horses Game Test at age 6 (von der Lippe, 2010). Maternal attachment had strong indirect effects on the child’s attachment style as well as on the child’s executive functioning (von der Lippe et al., 2010). This indicated that children of mothers with an insecure attachment style (e.g., insecure, avoidant) exhibited poorer executive functioning later on in childhood (von der Lippe et al., 2010).

In summary, children with insecure attachment styles have shown significant deficits in executive functioning skills and deductive reasoning skills.

“Your child was in foster care” (Burke Harris & Renschler, 2015)

Lewis-Morratry et al. (2012) studied a sample of children (aged 4-6) who had been placed in the foster care system before the age of 3. The average length of placement and average number of placements varied within the group, but all children had been placed in the foster care system before they turned 3. This group of foster care children was compared to a control group (never in foster care system) on a task of cognitive flexibility task, Dimensional Change Card Sort Task (executive functioning) (Lewis-Morratry et al., 2012). The data from this study showed that children who had been placed in the foster care system had less cognitive flexibility compared to the control group (Lewis-Morratry et al., 2012).
Fox & Arcuri (1980) assessed the cognitive functioning of children who were placed in foster care using commonly used measures of intelligence (i.e., Wechsler Preschool & Primary Scale of Intelligence, Wechsler Intelligence Scale for Children, and Wechsler Adult Intelligence Scale). The study had a sample of 163 children in foster care (aged 4 years 11 months to 18 years old) complete a one-time assessment of their intelligence (Fox & Arcuri, 1980). The authors concluded that children in foster care, regardless of amount of time in the foster care system, had strengths in areas of the assessment that focused on practical judgment and awareness of their surroundings (Fox & Arcuri, 1980). The children who were placed in the foster care system exhibited relative weaknesses in all formal education tasks, as well as tasks that involved visual analyses and abstract materials (Fox & Arcuri, 1980).

In summary, placement in a foster care setting can be associated with deficits in cognitive flexibility and overall weaknesses in tasks that require the use of visual analysis and abstract materials.

“Your child experienced harassment or bullying at school” (Burke Harris & Renschler, 2015)

Cassidy & Taylor (2005) assessed how being the victim of bullying affected a child’s executive functioning ability. The study included a sample of children, aged 12-15 years, and grouped them into three categories (Bully, Victim, and Control). Their executive functioning skills were assessed through a problem-solving inventory (Cassidy & Taylor, 2005). The data showed that children who were victims of bullying had greater deficits in problem solving when compared to the scores for the control group and the bully group (Cassidy & Taylor, 2005).

Rudolph et al. (2009) studied a group of children, aged 7-to-14-years, to better understand how exposure to peer victimization affected emotional and behavioral regulation. The researchers staged a situation where children had a difficult/unpleasant interaction with an
unfamiliar peer. Both children were then assessed for emotional and behavioral regulation through coding of their interaction (Rudolph et al., 2009). Results from the dyadic coding showed that children who experienced peer victimization during the study had increased emotion dysregulation and behavior dysregulation, all skills highly involved with the prefrontal cortex (Rudolph et al., 2009).

In summary, these findings suggest that experiencing bullying and harassment by peers may be associated with decreased executive functioning skills in the victims because behavior and emotion regulation are primarily controlled by the prefrontal cortex.

“Your child had a serious medical procedure or life threatening illness” (Burke Harris & Renschler, 2015)

Allen & Zigler (1986) studied a group of 5-to-10-year-old children with Leukemia (all were 5 months past initial diagnosis and at various stages of treatment) and a control group without a serious illness to understand how having a serious illness affects a child’s cognitive abilities. All children in the study were administered the Peabody Picture Vocabulary Test (PPVT) (Dunn, 1965) a measure of receptive vocabulary (Allen & Zigler, 1986). The data from this study showed that children with cancer performed worse in receptive vocabulary (lower PPVT scores) when compared to the healthy control group (Allen & Zigler, 1986). There were no other significant differences between the two groups on measures of adjustment and optimism/pessimism; the only area where deficits emerged was in receptive vocabulary (Allen & Zigler, 1986).

In summary, there is literature to show that when a child experiences the aforementioned ACEs items (abuse, neglect, bullying, parental incarceration, witnessing violence, being in foster care, serious medical illness), there are significant effects on the child’s cognition (e.g., Gould et
Previous research has established that when ACEs were experienced, there were effects on memory, intelligence, and executive functioning skills (e.g., Cassidy & Taylor, 2005; Johnson & Easterling, 2012; Rossman, 1998).

ACEs Items without Data for Cognitive Effects

A great deal of research has been conducted to better understand how experiencing life stressors early on in life can affect physical and mental health (Felitti et al., 1998), but based on a review of the current literature there is little evidence to support that research has been conducted to look specifically at neurocognitive functioning for the following eight ACEs items: “Close family member has a serious mental illness or attempted suicide; Child was physically assaulted by anyone; Household member using/abusing drugs or alcohol; Child lived with a caregiver who died; Child separated from caregiver due to immigration status; and Child was discriminated against based on race, religion, sexual orientation, etc.; Your child experienced verbal or physical abuse or threats from a romantic partner (i.e., boyfriend or girlfriend) [Teen Questionnaire only]; Your child was detained, arrested, or incarcerated [Teen Questionnaire only]” (Burke Harris & Renschler, 2015). Data exists for the impact of the ACEs on physical health outcomes (i.e., cardiovascular disease, sleep, weight) and mental health outcomes (i.e., anxiety, depression, other psychiatric conditions) (Felitti et al., 1998), but a literature search did not reveal that neurocognitive functioning has been studied as an outcome variable for the aforementioned ACEs items.

Early Life Stressors Impact on Neuropsychological Outcomes

Experiencing early life stressors is associated with poorer performance on neuropsychological measures when compared to the absence of early life stressors (De Bellis et al., 2013; Harms et al., 2017; Majer et al., 2010; Mueller et al., 2010; Parker et al., 2005;
Samuelson et al., 2010; Seckfort et al., 2008; Shin et al., 2018; Wilson et al., 2011). These findings were highlighted in a study by De Bellis and colleagues (2013). A group of children aged 6-17 years were separated into three distinct groups (Non-Maltreated, Maltreated without PTSD, and Maltreated with PTSD) and were assessed using measures that cover the areas of intelligence, motor skills, attention, receptive vocabulary, and memory (De Bellis et al., 2013). Both the maltreated groups exhibited worse performance on the IQ tasks as well as academic achievement when compared to the control group (De Bellis et al., 2013). Differences were also shown to exist between the non-PTSD and PTSD groups; those with PTSD performed significantly worse on tasks that involved visuospatial skills and attention skills (De Bellis et al., 2013). Those who had experienced sexual abuse performed worse on language and memory tests (De Bellis et al., 2013). Overall the experience of early life stressors had significant negative impacts compared to those who had not experienced early life stressors, and when the life stressors are broken down into specifics more differences become apparent (De Bellis et al., 2013).

A study conducted by Harms and colleagues (2017) also assessed the impact of early life stressors on neuropsychological functioning. Harms and colleagues (2017) studied a group of children aged 14-to-17-years and split into two groups, high levels of childhood stress and controls. Early life stress was assessed using the comprehensive Youth Life Stress Interview (Harms et al., 2017). General cognitive ability was assessed using the Cambridge Neuropsychological Test Automated Battery and an instrumental learning task was conducted while the participant was in an fMRI machine (Harms et al., 2017). It was found that those who had experienced early life stress displayed a slower pattern of learning positive and negative
associations on the instrumental learning task and ultimately displayed impaired cognitive flexibility during the task (Harms et al., 2017).

In summary, the experience of early life stressors has a negative impact on a person’s neuropsychological functioning (e.g., attention, cognitive flexibility, language, memory) and cognitive abilities (e.g., IQ) when compared to control samples.

**Current Study**

The current study examined whether the ACEs questionnaire can be used as a screening tool to identify youth at risk for neuropsychological deficits. The previously cited literature shows that when a child experiences early life stressors (e.g., abuse, neglect, imprisonment of a close family member), there are significant impacts on brain development as well as cognitive functioning (e.g., executive functioning, IQ scores, and memory) (Clarke-Stewart et al., 2000; Kosten et al., 2012; Poehlmann, 2005; Saleh et al., 2016). The previously cited literature has also shown that the ACEs questionnaire is a commonly used method for assessing the experience of early life stressors in a clinical capacity (Ereyi-Osas et al., 2020; Glowa et al., 2016; Wingenfeld et al., 2010). The negative impact of early life stressors has on mental and health outcomes is so profound that medical organizations, such as the American Academy of Pediatrics and the American Heart Association, have recommended the use of the ACEs questionnaire in clinical practice to identify those who are more at risk for negative health outcomes (e.g., cancer, heart disease, etc.) (American Heart Association, 2019; Garner et al., 2011). To date there are no published studies that have determined whether the ACEs questionnaire in whole can be used to predict the existence of neuropsychological deficits in youth. This current study aimed to fill this gap in the literature.
Assessing cognitive functioning through neurocognitive assessment can generate a clear picture of the specific cognitive abilities that are possibly being affected during childhood, a period of rapid brain development. During the developmental periods of middle childhood and early adolescence, there is a refinement of the neural connections, growth of gray matter and over brain volume, and increases in executive functioning skills, semantic memory, and episodic memory (Arian et al., 2013; DelGiudice, 2018; Ghetti & Bunge, 2012; Konrad et al., 2013; Mah & Ford-Jones, 2012; Willoughby et al., 2012). These changes in the structure and function in the brain can be attributed to chronic exposure to stress hormones (Anisman et al., 1998). Chronic exposure to stress hormones in the brain can led to neuronal death, lack of activation in brain regions (i.e., hippocampus, prefrontal cortex), and reduction of volume in the brain (Anisman et al., 1998; Brenhouse & Andersen, 2001) which have been shown to be related to neurocognitive functioning (Farah et al., 2006; Squire & Zola-Morgan, 1991; Teicher et al., 2003).

Research Questions and Hypotheses

RQs 1,2,&3: Compared to children with no ACEs, do children who experience early life stressors (e.g., ACEs) have differences in neurocognitive abilities as indicated by the total score on the Neurocognitive Index (NCI) composed of the following five composite scores: (1) Composite Memory [Subtests: Verbal Memory Test Immediate and Delay, and Visual Memory Test Immediate and Delay], (2) Psychomotor Speed, (3) Reaction Time, (4) Complex Attention [Subtests: Stroop Test, Shifting Attention Test, Continuous Performance Test], and (5) Cognitive Flexibility? If there are differences between groups on the total score of the Neurocognitive Index, do differences exist between groups on the Composite Memory score? Do differences exist between groups on the Complex Attention composite score? No research questions were developed with regard to psychomotor speed, reaction, time, and cognitive
flexibility. Research questions were not developed for these domains due to limited existing literature addressing these specific domains.

**Hypotheses 1, 2, & 3:** Based on prior research conducted in this area (Poehlmann & Fiese, 1994; Mills et al., 2010; Gould et al., 2012; etc.) it can be hypothesized that significant differences in three specific domains of cognitive functioning (i.e., Neurocognitive Index, Composite Memory, and Complex Attention) will exist between children who have experienced early life stress and the control group who did not experience early life stress.

**RQ 4:** If between-groups differences exist in Composite Memory score, what specific tests show differences?

Since limited research has been done looking at where differences may occur in specific cognitive tests, no hypotheses will be made regarding between-groups performance on specific cognitive tests that comprise the index scores.

**RQ 5:** If between-groups differences exist in Complex Attention composite score, what specific tests show differences?

Since limited research has been done looking at where differences may occur in specific cognitive tests, no hypotheses will be made regarding between-groups performance on specific cognitive tests that comprise the index scores.

**RQ 6:** Does the number of ACEs predict deficits in cognitive functioning?

Research has shown that as the number of ACEs experienced increases, there is an increased risk for mental and physical health conditions (e.g., heart disease, stroke, cancer, COPD, anxiety, depression, PTSD, etc.) in young and middle aged adults (Chang et al., 2019). It has been shown that the presence of early life stressors can lead to structural and functional changes in the brain, mainly negative changes (Arian et al., 2013; DelGiudice, 2018; Ghetti &
To date, no extant research has examined whether the number of early life stressors/ACEs predicts functioning. Previous research has looked at early life stress exposure as dichotomous as opposed to continuous, thereby not taking into account the number of life stressors a person has experienced. Because there is no evidence at this time on which to formulate a hypothesis, this will remain a research question. Research questions 4, 5, and 6 will only be addressed if previous analyses reveal that children in the life stress group have lower neurocognitive scores on the Neurocognitive Index, Composite Memory, and Complex Attention composite.

**Methods**

**Participants**

The current study utilized a sample of 53 participants (aged 8 years through 17 years), 20 participants in the No ACEs condition and 33 in the ACEs condition (1 or more). Participants were recruited via avenues such as WVU ENews, WVU Alumni Parents’ Group, Social Media, and Community Venues, and were instructed to contact the researcher via email to express interest in having their child participate in the study. A 60 participant sample size was generated by conducting a power analysis using GPower Version 3.19.7. This power analysis was run using a medium effect size ($d=0.65$), an $\alpha$ error probability of 0.05, power=0.80, and an allocation ratio of 1. A medium effect size was determined to be appropriate by generating effects sizes from the Gould and colleagues (2012) study that examined neurocognitive functioning in an adult sample (18-54 years) with a history of child sexual abuse compared to a no-child-sexual-abuse control group. The effect size for spatial working memory errors was 0.64, attention shift was 0.41, attention shift total errors was 0.51, and planning abilities (executive functioning skill) was 0.68. Effect sizes were also generated from the Navalta and colleagues
(2006) study in order to further justify the use of a medium effect size in the proposed study. A sample of college aged women were assessed to study the impact of childhood sexual abuse on memory, a group of women with childhood sexual abuse history was compared to a group of women with no childhood sexual abuse history (Navalta et al., 2006). The effect size for Visual Memory was 0.95 and the effect size for Global Memory was 0.58.

**Demographics**

This study utilized a sample of 53 participants. The mean age for the child participants was 12.42 years ($SD=3.15$). The mean child age for the No ACEs group was 11.45 years ($SD=2.89$) and the mean child age for the ACEs group was 13.00 (3.19). The majority of participants resided in a two parent married or unmarried household with siblings, grandparents, or other family members. For the total sample there were no children with diagnoses of intellectual disability, TBI/concussion, hearing or vision problems after corrections. See Tables 2, 3, 4, and 5 for additional demographic information (Total ACEs experienced, Child Race/Ethnicity, Child Sex/Gender, Child Diagnoses).

The mean age for the parents was 44.58 years ($SD=5.92$). The mean age for the parents with children in the No ACEs group was 43.79 years ($SD=4.70$) and the mean age for parents with children in the ACES group was 45.03 years ($SD=6.54$) (see Table 2). For the parents involved in the study 3 identified as male (5.7%) and 50 identified as female (94.3%). The average family income for participants was 10.26 ($SD=1.40$) which falls into the $90,000 to $99,999 category. The average parent education level was 5.89 ($SD=1.12$) which falls in between the 4-year college degree (5) and Master’s degree (6) categories. For family income, 1 family reported $30,000-$39,999/year, 1 family reported $50,000-$59,999/year, 3 families reported $70,000-$79,999/year, 6 families reported $80,000-$89,999, 6 families reported $90,000-
$99,999/year, and 36 families reported an income over $100,000/year. When asked to report their level of access to their child’s life history, 50 parents reported that they had access to their child’s life history; 1 parent reported that there was a period of time they did not have access to their child’s life history but that they were relatively certain of the events their child experienced, and 2 parents failed to answer this question. See Tables 6 and 7 for additional parent demographic information (parent relationship to child and parent education).

Materials

Demographic Form (Krackow, 2007,2021)

The parent completed the demographic form via Qualtrics. The parent provided the following information with regard to the child: Birthdate; biological sex at birth; gender; race/ethnicity; gross family income of the household in which the child spends the greatest number of hours per week; constellation of members in the home in which the child spends the most time; whether the child has been diagnosed with/the parent has concerns the child may have a learning disability; intellectual disability; ADHD; autism spectrum disorder; concussion/traumatic brain injury; major medical problems; motor coordination problems that required occupational therapy; hearing loss (not 100% corrected with hearing aids); vision loss (not 100% corrected with glasses); other problems, and handedness. The parent provided the following information about themselves: parent relationship to child, gender, age, race/ethnicity, and highest level of education completed.

Center for Youth Wellness (CYW) Adverse Childhood Experiences Questionnaire (ACE-Q) Child and Teen (Burke Harris and Renschler, 2015)

The ACEs questionnaire is a screening tool completed by a parent or caregiver and used by primary care providers to identify possible exposure to early life stressors. This questionnaire
identifies ACEs that cover three main domains: Abuse, Neglect, and Household Dysfunction (Bucci et al., 2015). These questionnaires were developed based on the original ACEs questionnaire created by Felitti and colleagues (1998) in the CDC/Kaiser Permanente study. This 17 item (child version) and 19 item (teen version) questionnaire includes all 10 original items from the original ACEs questionnaire plus 7 added items for the child version and 9 added items for the teen version based on input from experts and community stakeholders (Purewal et al., 2016). Instead of checking off each individual item the child has experienced, the parent mentally calculates the totals and writes down a total number for Section 1 and Section 2. This is done in order to ensure confidentiality is maintained as the parent discloses the child’s exposure to adverse childhood experiences. These questionnaires have exhibited face validity and concurrent validity with other measures of adverse childhood experiences (e.g., Original ACEs questionnaire, Philadelphia Childhood Adversity Questionnaire, World Health Organization’s (WHO) ACEs International Questionnaire) (Bethell et al., 2017). Because this measure is used for screening purposes in a medical setting and is not intended to be a diagnostic tool, extensive psychometric research has been conducted. The main focus of the psychometric research has been on ensuring that this screener tool is comparable to similar screener tools for childhood adverse experiences. It should be noted that this tool is widely accepted and used in the pediatric field as screener tool for identifying children with potential exposure to adverse childhood experiences (Bethell et al., 2017).

*CNS-Vital Signs Neuropsychological Test (CNS Vital Signs, 2019)*

This neuropsychological assessment was developed to be delivered remotely; it was designed to be a screener assessment and is not to be used for diagnostic purposes. This program assesses neuropsychological functioning as a whole (Neurocognitive Index [NCI] score) as well
as composite scores that make up the NCI (Composite Memory, Psychomotor Speed, Reaction Time, Complex Attention, and Cognitive Flexibility). Research on reliability and validity were conducted using a sample of 1,069 participants (aged 7-to-90-years) to assess whether this automated, online assessment is comparable to the neuropsychological tests on which it was based. It was shown that this online assessment had test-retest reliability that was comparable to similar neuropsychological assessments completed in person and online (Gualtieri and Johnson, 2006). When concurrent validity was assessed, it was determined that the CNS Vital Signs assessment tests were significantly comparable to the tests on which they were based (copyrighted testing materials such as WISC, WAIS, Conners CPT). When discriminant validity was also assessed in this study, it was found that the CNS Vital Signs system was able to discriminate between healthy control participants and those with mild to severe brain injuries, ADHD, dementia, and depression just as well as traditional neuropsychological measures (Gualtieri and Johnson, 2006). This assessment tool has been found to be sensitive to identifying individuals who are malingering or those with conversion disorders (Gualtieri and Johnson, 2006). Validity indicators are also generated for the NCI and composite scores at the same time all other scores are generated. All descriptions of the neuropsychological tests are derived from the CNS Vital Signs Interpretation guide (CNS Vital Signs, 2019).

Verbal Memory (Immediate and Delay): Assesses written word recognition memory

Fifteen words are shown to the participant, one at a time at an interval of every 2 seconds. During the immediate recognition test portion, the participant must identify the fifteen words presented to them (by pressing the space bar for a word that was previously presented to them) as they are intermixed with fifteen new words. Six tests are administered, and then the delayed
recall task is administered. The administration is identical to the immediate recall task. (CNS Vital Signs, 2019)

**Visual Memory (Immediate and Delay):** Assesses recognition memory for objects (abstract figures and shapes)

Fifteen shapes are shown to the participant, one at a time at an interval of every 2 seconds. During the immediate recognition tested portion, the participant must identify the fifteen shapes presented to them (by pressing the space bar for a word that was previously presented to them) as they are intermixed with fifteen new shapes. Five tests are administered, and then the delayed recall task is administered. The administration is identical to the immediate recall task (CNS Vital Signs, 2019).

**Finger Tapping:** Assesses fine motor control and motor speed

The system prompts the participant to press down on the space bar with the right index finger as many times as they can in a 10 second period. One practice round is completed and then three test trials are administered. The same process is completed with the left index finger (CNS Vital Signs, 2019).

**Symbol Digit Coding:** Assesses complex attention, information processing speed, visual-perceptual speed, and complex information processing accuracy

The participant is shown a figure with eight symbols and eight numbers (2-9) that correspond to the symbols. The participant is also shown a figure that contains eight symbols; below each symbol is a blank box. The participant is then prompted to fill in the empty boxes with the correct number (CNS Vital Signs, 2019).

**Stroop Test:** Assesses reaction time, inhibition/disinhibition, and executive functioning skills
For the first section of the test the participant is prompted to press the space bar when seeing the target word. The words Red, Yellow, Blue, and Green, all appearing in black font, flash on the screen in a random order; one of these words is the target word. On the second test the words Red, Yellow, Blue, and Green, all appearing in color font, flash on the screen in a random order; the participant is instructed to press the space bar when the font color is the same as the word. The final test has the words Red, Yellow, Blue, and Green, all appearing in color font, flash on the screen in a random order, and the participant is instructed to press the space bar when the font color is not the same as the word (CNS Vital Signs, 2019).

**Shifting Attention Task:** Assesses executive functioning skills, shifting set rules, reaction time, and rapid decision making

The participant is prompted to select one of two objects that fulfills the rule (matching shape or color). Three figures appear on the screen at one time, one at the top (either a circle or square and either red or blue) and two on the bottom (one circle and one square, one red and one blue). The participant is then told to match one of the bottom figures to the top figures, based on randomly changing rules (match color or match shape) (CNS Vital Signs, 2019).

**Continuous Performance Task:** Assesses sustained attention, impulsivity, and vigilance

The participant is prompted to attend to the target stimulus (“B”) and they are instructed to press the space bar when “B” appears on the screen and to not press the space bar when any other letter of the alphabet appears on the screen (CNS Vital Signs, 2019).

**Procedure**

This study was approved by the West Virginia University IRB. Following parental response to the advertisement, the researcher communicated via email with the parent to schedule a time to meet via Zoom to complete the study. Once a time was scheduled, the
researcher emailed a Zoom link and a Qualtrics link to the email address provided by the parent. In this email the researcher also asked the parent to ensure that a distraction free space in the home will be set up on testing day for the child participant to use during testing.

Following parental consent and child assent, the child was asked to leave the room while the researcher obtains the child’s name and birthdate from the parent for the purpose of creating a participant profile in the assessment system. While on Zoom with the researcher the parent also completed a demographic form and the ACEs questionnaire contained within Qualtrics at the end of which they were offered counseling resources in the event of distress.

Once the forms were completed, the parent brought the child back into the room and ensure the room was an optimal testing environment (i.e., no electronic devices except for computer being used for testing, no other people, no paper or objects in or near the vicinity of the computer, the room is quiet). While the parent quickly glanced around the room and made any last minute adjustments to it, the researcher inputted the participant information (name, birthdate, and email) into the assessment system in order to generate a participant profile. When the participant profile was generated, the researcher generated a unique testing code for the participant and emailed the link to access the testing to the email address provided by the parent. The participant then received an email automatically generated by the CNS Vital Signs system stating that a provider at WVU has prescribed testing for them to complete.

The researcher then confirmed with the parent and the child participant that they have received the email that contained the link to the remote assessment. The parent remained in the room to assist the child as needed until the official testing session begins. The participant clicked the link and were be redirected to a welcome page, which asked the participant to read and check off instructions and reminders about the testing environment (i.e., have a working computer or
laptop, quiet environment, no pausing or stopping during the testing, wearing corrective eyewear if necessary). The system then prompted the child to watch a short video provided by the assessment service outlining the general procedure of the testing session and what to expect during the testing. The video informed the participant that testing should take approximately 45 minutes to 1 hour; and that the participant should be in a distraction free environment; testing cannot be stopped or paused; there will be breaks in between individual tests; they should be completing the testing during normal waking hours; and that they should be wearing corrective eyewear if necessary. Prior to entering the testing session, the system reminded the participant to take a bathroom break, stretch their legs, put on their corrective eyewear, and turn off all electronic devices except for the computer/laptop. The system then prompted the participant to enter their unique eight digit testing code provided in the email from the testing service. The system asked the participant to ensure that their keyboard was working by having the participant press all the number keys (1-9), both shift keys, the enter key, and space bar. The testing session did not start until the participant completes this task. For the entirety of the testing session, the researcher was on the Zoom call with their video turned off and audio muted to provide technical support if needed and ensure the testing environment remains distraction free.

At the beginning of the testing session the system reminded the participant that the testing would take approximately 45 minutes to 1 hour to complete and that they should remain focused and put forth their best effort for the whole testing session. For each individual test instructions were provided, the system prompted the participant to read the instructions thoroughly, and press the enter key once they are ready to start the test. Once the enter key was pressed a countdown from three begins and a loud beep sounds when the test starts. Children completed the tests as designated by the system in the following order: Verbal Memory Immediate, Visual Memory
Immediate, Finger Tapping, Symbol Digit Coding, Stroop Test, Shifting Attention Task, Continuous Performance Task, Verbal Memory Delay, Visual Memory Delay. A message on the screen appeared when the testing is complete. When all the tests were completed the system notified the participant that all testing is complete. At this time the system sent a notification to the researcher via email that the participant had completed the testing session.

Once all data was collected, the participant was reminded that they will be mailed a $30 gift card.

**Scoring**

*CYW-ACE Q Scoring*

Once the parent completed the CYW-ACE Q the researcher transferred to the database the total number of ACEs the parent endorsed. This score served as the total number of ACEs the child has experienced. After data collection of each individual, participants were assigned to either a “No ACEs group” and the “ACEs group.” Analyses were conducted using the two groups.

*CNS Vital Signs Scoring*

The CNS Vital Signs system automatically generated a score report that was only accessible to the researcher. In this score report, composite scores were displayed with the subject score, standard score, percentile, valid score (yes or no), and where the score lands on an above to very low rating on percentile range and standard score range. The range went from Above Average (Standard score: >109, Percentile: >74), Average (Standard Score: 90-109, Percentile: 25-74), Low Average (Standard Score: 80-89, Percentile: 9-24), Low (Standard Score: 70-79, Percentile: 2-8), and Very Low (Standard Score: <70, Percentile: <2). Scores were
also generated for individual subtests; each individual subtest receives a Score, Standard Score, and Percentile.

Results

Preliminary Analyses

Skew and kurtosis values and outliers were generated for all variables used in the following analyses. Extreme outliers for individual subtests as well as composite scores and overall scores were removed from the analyses. The Neurocognitive Index had 3 missing data points due to computer glitches (2 from the No ACEs group and 1 from the ACEs group), after extreme outliers were removed the Neurocognitive Index had 2 additional data points removed (both from the ACEs group), leaving a sample size 48. The Composite Memory Index had no missing data points and no extreme outliers, resulting in a sample size of 53. The Complex Attention Index had no missing data points, after extreme outliers were removed the Complex Attention Index had 5 data points that were removed (1 from the No ACEs group and 4 from the ACEs group), leaving a sample size of 48.

Correlations were also conducted using Spearman’s Rho correlations. Correlations between the total number of ACEs experienced, the Neurocognitive Index (NCI), the Composite Memory Index, the Complex Attention Index, Child Age, Child Race/Ethnicity, Child Sex, Parent Education, and Family Income. The following correlations were significant at the $p < .001$ level: NCI and Composite Memory; NCI and Complex Attention; and Child Sex and Parent Education. The following correlations were significant at the $p < .05$ level: Complex Attention and Family Income; and Child Race/Ethnicity and Special Education. See Table 1 for all correlation values.
An Independent Samples T-Test was run and it was determined that there were no significant differences between the child ages of the two groups $t(51)=-1.77, p=.306$.

**Main Analyses**

Three independent samples T-Tests (see Table 8) were conducted to assess whether group differences exist for the following three components of cognitive functioning: Neurocognitive Index (overall cognitive functioning), Composite Memory, and Complex Attention between the no ACEs group and the ACEs group. The data showed that differences between the no ACEs group and the ACEs group for the Neurocognitive Index were not significantly different. The data showed that differences between the no ACEs group and the ACEs group for Composite Memory were also not significantly different, nor were the data significantly different between the no ACEs group and the ACEs group for the Complex Attention index.

A linear regression was conducted and there was not a significant relationship between the total number of ACEs experienced and Neurocognitive Index ($B=0.01, SE=0.03, p=0.81$), Composite Memory Index ($B=-0.001, SE=0.01, p=0.93$), and Complex Attention Index ($B=0.01, SE=0.02, p=0.61$) scores.

A sensitivity analysis was conducted to determine what effect sizes would have been required in this study for significant differences between the ACEs and No ACEs groups to have emerged. The following effect sizes would have been needed: Neurocognitive Index $d= 0.85$, Composite Memory Index $d= 0.81$, and Complex Attention Index $d=0.84$.

Several participants endorsed being diagnosed with disorders or conditions that could impact their test scores (e.g., ADHD, ASD, motor coordination problems, etc.). Therefore, additional effect sizes were conducted with those participants who endorsed diagnoses removed.
from the data analysis. This was done in order to gain a better understanding what factors may be contributing to the non-significant results. The results remained the similar when compared to the original effect sizes generated for this study, for the Neurocognitive Index ($d = -0.33$), and the Composite Memory index ($d = -0.05$), but Complex Attention increased from a small effect size to a medium effect size ($d = -0.58$).

**Discussion**

The results of this study provided information in an attempt to understand if the Adverse Childhood Experiences Questionnaire could be used a screener tool to identify children in need of neuropsychological testing. Based on previous research (e.g., Gould et al., 2012; Mills et al., 2010; Poehlmann & Fiese, 1994), it was hypothesized that significant differences in three specific domains of cognitive functioning (i.e., Neurocognitive Index, Composite Memory, and Complex Attention) would exist between children who have experienced early life stress and children who did not experience early life stress, as measured by the ACEs questionnaire. The findings do not support the original hypotheses. The results showed non-significant differences on the Neurocognitive Index, Composite Memory Index and Complex Attention Index between children with no ACEs and children with ACEs. There was also not a significant relationship between the number of ACEs experienced and the aforementioned indices. This study contributes to the literature by demonstrating that the Adverse Childhood Experiences Questionnaire may not be an adequate screening tool for identifying children who could benefit from neuropsychological testing as a result of exposure to early life stressors. It is important to note that originally it was decided that the subtests that comprised the Neurocognitive Index, the Composite Memory Index, and the Complex Attention Index would not be analyzed if significant differences between the groups did not exist. A prospective analysis found that a
higher ACEs score at Wave I in adolescence (aged 11-18 years) is linked to poorer cognition tested 14 years later in adulthood at Wave IV (Hawkins et al., 2021). This analysis indicates that clinically significant deficits in cognitive functioning may not be relevant until adulthood and that the impact of early life stressors continues as the individual develops.

There are several reasons why significant differences may not have emerged. Due to recruitment difficulties, data collection was discontinued after 53 participants as opposed to the original 60 participants proposed. Multiple attempts were made to contact pediatricians’ offices with no response and multiple advertisements were placed with few responses. The number of participants varies widely in the existing literature; 60 participants in two groups (Farah et al., 2006), 129 participants in two groups (Saleh et al., 2016), 340 participants in three groups (Clarke-Stewart et al., 2000), but these sample sizes were larger than the one in this study. In addition, data from participants was not included in the analyses if the participant experienced computer difficulties such that full data collection was not possible and data was removed from the analyses if the data point was identified as an extreme outlier during preliminary analyses, which further reduced the sample size for some analyses.

It is unclear which ACEs children in the current study experienced because this study was designed to avoid having participants endorse specific ACEs items due to reporting concerns of potential abuse. If participants were to have endorsed specific items, it could have led to a better understanding of ACEs that participants experienced, as well as allowed the researchers to distinguish between ACEs that are potentially time limited occurrences (e.g., parental divorce) versus chronic stressors (e.g., community violence). The average number of ACEs endorsed in this study was low compared to other studies that assess early life stressors. In a study by Saleh and colleagues (2017) that included a sample of 69 adult participants, the average ACEs score
was 2.7. The average ACEs score for the current study is also lower than the reported average ACEs score for adults in West Virginia, 1.4 (Bureau for Public Health, 2015). Certain ACEs, such as sexual abuse and household dysfunction, can have a greater impact of mental health outcomes when compared to other ACEs such as parental divorce (Atzl et al., 2019; Schilling et al., 2008). Specifically, there is a substantial body of literature showing no long term psychosocial effects of parental divorce (Clarke-Stewart et al., 2000; Poehlmann & Fiese, 1994) with regard to chronic stress, also deprivation ACEs (e.g., neglect) predicted poorer verbal and working memory (Hawkins et al., 2021). In the future it would be wise to remove the parental divorce item from the ACEs questionnaire. Navalta and colleagues (2006) found that for every year of early life stressors experienced, short-term memory (2.4%), verbal memory (2.0%), visual memory (1.9%), and global memory (2.3%) were negatively impacted. It is clear that the number of ACEs, as well as the specific ACEs experienced, have a large impact on long-term and short-term effects of early life stress.

Additionally, the sample included in this study was comprised of highly educated families in a higher SES bracket. Those parents who have received more formal education and are within a higher SES bracket tend to have greater access to resources that could help to negate the negative impact of experiencing ACEs. Previous studies have shown that SES and education are significant contributing factors in cognitive performance. Farah and colleagues (2006) showed that memory, language (e.g., receptive language and novel word learning), and executive functioning were strongly related to SES and that an uneven pattern of differences exist between low and middle SES children. Clarke-Stewart et al. (2000) found that parents who were divorced had significantly lower education levels and lower income compared to expenses, and children from those families also had significantly lower IQ scores. Early life stressors also impact
educational attainment. People who have experienced early life stressors have significantly lower completion of all levels of education (including high school and higher education) (Cheong et al., 2017). While there are various risk factors there are also known protective factors that co-occur with better access to resources, such as tutoring, academic support, access to better schools, and access to additional services. Children whose parents are in a higher SES bracket hear more words per day, thus giving them an advantage in language learning (Adamson et al., 2014). With these factors in mind it’s important to understand that this sample falling into a high SES category how the protective factors helped to contribute to the results seen. Recruiting participants from pediatricians’ offices could provide for a more ecologically valid sample for this type of study.

Another important piece of information to take into consider is the homogeneity of samples in the existing literature. Previous studies of early life stressors often focus on one specific early life stressor (i.e., parental divorce, physical abuse, neglect, parental substance use). This produces a fairly homogenous sample that allows for some control of understanding the impact of one particular early life stressor as compared to the more general impact of one or several early life stressors. It is also important to understand that several of the studies on early life stressors also have several other areas of foci (e.g., depression, anxiety, physical health) that impact the participants recruited for their studies and can influence the results.

The testing software selected in this study was originally selected due to COVID-19 restrictions to allow data collection to be completed remotely and virtually. The software, while psychometrically sound, is meant for research only but data based on it has limitations due to being completed virtually. Using in person neuropsychological tests where distractions can be controlled and technology issues are not a concern could lead to more accurate results. In
addition, more comprehensive neuropsychological testing could deepen our understanding of whether the ACEs questionnaire can be used as a screener for neuropsychological deficits.

Based on the responses to the survey, several parents indicated that their children had diagnoses of ADHD, learning disabilities, other developmental disorders (apraxia of speech and selective mutism, autism spectrum disorder), a motor disorder, and an unspecified medical condition. In order to better understand if these diagnoses had an impact on the data, these effect sizes were calculated without data from these participants. When these participants were removed from analyses, effect sizes remained minimal for the Neurocognitive Index and Composite Memory, but increased from small to medium for Complex Attention, albeit in the opposite direction from expected.

**Limitations**

A limitation of this study was the sample size; while it was manageable for dissertation project, a larger sample size could have provided a better representation of the US population and would have yielded greater power. Although the total sample size was just shy of the necessary sample size generated by the power analyses, the effect sizes found in the current study did not reach those on which the power analyses were based. An additional limitation to this study was that parents did not have to report if their child was currently taking psychotropic medication. This could have a significant impact on testing scores especially if the child was being medicated for attention-deficit hyperactivity disorder. An additional consideration is that the subjects knew that they were undergoing neuropsychological testing as well as being watched by the researcher, this could have prompted an increase in performance and concentration due to evaluative effects (Mahtani et al., 2018). As previously discussed, the inability to understand which ACEs were endorsed by individual participants and in turn which
ACEs were the most highly endorsed is considered a limitation given that different ACEs have different levels of impact. Another limitation identified is that this sample of participants consisted of mostly highly educated parents, as well as families that were highly motivated to be involved in research. This potentially allowed for a sample that had access to more resources, this could have led to children having access to resources that could help to reduce the impact ACEs have on functioning (e.g., tutoring, school services, practicing skills at home). Those with greater access to resources and who are motivated to participate in research studies are not representative of the US population and may not be capturing those who are the most impacted by early life stressors.

Relatedly, the fact that this study was conducted in the midst of the COVID-19 pandemic generated a unique set of circumstances for data collection and possibly for the participant pool. The additional pressure of the pandemic may have opened up free time for families with greater resources, but made it difficult for families with limited resources to participate in extra activities such as research.

**Future Directions**

While this study did have limitations and the proposed hypotheses were not supported, areas were identified for future research. A larger sample size would allow for a better understanding of trends and averages amongst a population where there is great variation in the number of early life stressors experienced. With more data points, there would be increased power for additional analyses to be run to better understand if there are specific areas of cognitive deficits.

Another future direction would to be to recruit a more diverse sample that is representative of the United States including greater racial/ethnic diversity. The sample in this
study included a highly educated, higher SES population and relied on participants that were actively searching out opportunities to engage in research. A sample more representative of the United States would allow for a better understanding of how early life stressors impact all segments of the population.

An additional area for future studies would be to conduct testing in person. The software used was developed for research purposes and utilizing the standardized neuropsychological tests could provide for a more accurate diagnostic view of the child’s functioning. Additionally, in person testing would allow for researchers to control the testing environment and ensure that the testing environment was as distraction free as possible. This would also eliminate the possibility of computer errors affecting the scores. This would also allow for families with limited access to a consistent internet connection or limited access to a device that would allow them to participate to participate in a study like this.

Conclusions

Overall, this study did not produce the results hypothesized but future directions and areas for future consideration were identified. The ACEs group did not perform significantly poorer than the no ACEs group on measures of overall cognitive functioning, memory, and attention. Socioeconomic Status and parental education are known to contributors to minimizing poorer performance on cognitive measures. In addition, a more sensitive neuropsychological testing software could help to better differentiate the impact of ACEs on neuropsychological functioning. While this study did not find the hypothesized results, it did help to shed light on areas where further research can expand and improve upon in future studies.
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https://doi.org/10.1055/s-0030-1263161


Appendix A: Results Tables

Table 1

_Correlations Among and Descriptive Statistics for Key Study Variables_

<table>
<thead>
<tr>
<th>Variables</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.Total ACEs</td>
<td>0.23</td>
<td>-0.001</td>
<td>0.149</td>
<td>0.077</td>
<td>-0.112</td>
<td>0.156</td>
<td>-0.086</td>
<td>0.100</td>
<td></td>
</tr>
<tr>
<td>2.NCI</td>
<td></td>
<td>0.510**</td>
<td>0.635**</td>
<td>0.076</td>
<td>0.242</td>
<td>-0.098</td>
<td>0.028</td>
<td>-0.215</td>
<td></td>
</tr>
<tr>
<td>3.Composite Memory</td>
<td></td>
<td>0.126</td>
<td>-0.094</td>
<td>-0.061</td>
<td>-0.247</td>
<td>0.039</td>
<td>-0.189</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.Complex Attention</td>
<td></td>
<td></td>
<td>0.028</td>
<td>0.041</td>
<td>0.010</td>
<td>0.338*</td>
<td>-0.071</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.Child Race</td>
<td></td>
<td></td>
<td></td>
<td>0.078</td>
<td>-0.069</td>
<td>-0.262</td>
<td>0.325*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.Child Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.383**</td>
<td>-0.166</td>
<td>-0.116</td>
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<td></td>
</tr>
<tr>
<td>7.Education Level</td>
<td></td>
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<td></td>
<td></td>
<td>0.042</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.Family Income</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.Special Ed.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Notes. N’s range from 43 to 53 due to missing data.
NCI=Neurocognitive Index. Special Ed.=Special Education. Child Race = Child Race/Ethnicity
* p < .05 ** p < .001

Table 2

_Total ACEs_

<table>
<thead>
<tr>
<th>Total ACEs M=1.26(1.33)</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>20</td>
<td>37.7</td>
</tr>
<tr>
<td>1</td>
<td>13</td>
<td>24.5</td>
</tr>
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<td>2</td>
<td>12</td>
<td>22.6</td>
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<td>3</td>
<td>3</td>
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<td>4</td>
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</tr>
<tr>
<td>5</td>
<td>1</td>
<td>1.9</td>
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</table>
### Table 3
*Child Race/Ethnicity*

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<tr>
<th>Race/Ethnicity</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asian/Asian American</td>
<td>1</td>
<td>1.9</td>
</tr>
<tr>
<td>Caucasian</td>
<td>44</td>
<td>83.0</td>
</tr>
<tr>
<td>Hispanic/Latinx</td>
<td>1</td>
<td>1.9</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>1.9</td>
</tr>
<tr>
<td>Missing</td>
<td>6</td>
<td>11.3</td>
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### Table 4
*Child Sex and Gender*

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<tr>
<th>Child Sex</th>
<th>N</th>
<th>%</th>
<th>Child Gender</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>24</td>
<td>45.3</td>
<td>Male</td>
<td>24</td>
<td>45.3</td>
</tr>
<tr>
<td>Female</td>
<td>29</td>
<td>54.7</td>
<td>Female</td>
<td>28</td>
<td>52.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Non-Binary</td>
<td>1</td>
<td>1.9</td>
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### Table 5
*Child Diagnoses*

<table>
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<th>Diagnoses</th>
<th>N</th>
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<tr>
<td>ADHD</td>
<td>3</td>
</tr>
<tr>
<td>Learning Disability</td>
<td>1</td>
</tr>
<tr>
<td>Other Medical Disorder</td>
<td>3</td>
</tr>
<tr>
<td>Autism Spectrum Disorder</td>
<td>1</td>
</tr>
<tr>
<td>Developmental Disorder</td>
<td>2</td>
</tr>
<tr>
<td>Motor Coordination Problems</td>
<td>1</td>
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<tr>
<td>Other problem not listed</td>
<td>1</td>
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*Notes.* Percentages were not listed due to participants marking multiple items.
Table 6

*Parent Relationship to Child*

<table>
<thead>
<tr>
<th>Relationship to Child</th>
<th>N</th>
<th>%</th>
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<tbody>
<tr>
<td>Biological Mother</td>
<td>47</td>
<td>88.7</td>
</tr>
<tr>
<td>Biological Father</td>
<td>2</td>
<td>3.8</td>
</tr>
<tr>
<td>Non-biological Mother</td>
<td>1</td>
<td>1.9</td>
</tr>
<tr>
<td>Non-biological Father</td>
<td>1</td>
<td>1.9</td>
</tr>
<tr>
<td>Other Legal Guardian</td>
<td>2</td>
<td>3.8</td>
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</table>

Table 7

*Parent Education*

<table>
<thead>
<tr>
<th>Education</th>
<th>N</th>
<th>%</th>
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<tbody>
<tr>
<td>Associate’s Degree/Some College</td>
<td>6</td>
<td>11.3</td>
</tr>
<tr>
<td>4 year College/University Degree</td>
<td>14</td>
<td>26.4</td>
</tr>
<tr>
<td>Master’s Degree</td>
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<td>32.1</td>
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<tr>
<td>Doctoral Degree</td>
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<tr>
<td>Professional Degree</td>
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## Table 8

*Independent Samples T-Test*

<table>
<thead>
<tr>
<th></th>
<th>$t(46,51,46)$</th>
<th>$p$</th>
<th>$d$</th>
<th>No ACEs</th>
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<th></th>
<th>ACEs</th>
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<tbody>
<tr>
<td></td>
<td>$N$</td>
<td>$M$</td>
<td>$SD$</td>
<td>$N$</td>
<td>$M$</td>
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<td></td>
<td></td>
<td>$N$</td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>Neurocognitive Index</td>
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<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>-.446</td>
<td>.873</td>
<td>-.14</td>
<td>18</td>
<td>93</td>
<td>11.55</td>
<td>30</td>
<td>94.67</td>
<td>13.08</td>
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<td></td>
</tr>
<tr>
<td>Composite Memory</td>
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<td>20</td>
<td>92.6</td>
<td>21.81</td>
<td>33</td>
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<td>Complex Attention</td>
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<td>-1.139</td>
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<td>95.26</td>
<td>16.87</td>
<td>29</td>
<td>100.66</td>
<td>15.47</td>
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Table 9

<table>
<thead>
<tr>
<th>Authors</th>
<th>ACEs Question (All items verbatim) (Burke-Harris and Renschler, 2015)</th>
<th>Population</th>
<th>Control Group</th>
<th>Tests Administered</th>
<th>Areas of Functioning</th>
<th>Results</th>
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<tbody>
<tr>
<td>Clarke-Stewart et al., 2000</td>
<td>Your child’s parents or guardians were separated or divorced</td>
<td>Children (divorce in first 3 years of life)</td>
<td>Y</td>
<td>Bayley Scale (15 months and 24 months), Reynell Development of Languages Scale (36 months)</td>
<td>Overall Cog Functioning</td>
<td>No significant differences in cognitive functioning (single v. 2 parent), control for maternal education and family income</td>
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<tr>
<td>Poehlmann &amp; Fiese, 1994</td>
<td>Your child’s parents or guardians were separated or divorced</td>
<td>Toddlers (18-41 months)</td>
<td>Y</td>
<td>Bayley Scale and Stanford-Binet</td>
<td>Overall Cog Functioning and IQ Scores</td>
<td>Poorer scores for single parent homes compared to 2 parent homes (significant difference)</td>
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<tr>
<td>Poehlmann, 2005</td>
<td>Your child lived with a household member who served time in jail or prison</td>
<td>Children (2-7 years)</td>
<td>Y</td>
<td>Stanford-Binet</td>
<td>IQ scores (overall only)</td>
<td>Children w/ incarcerated mothers=lower IQ scores.</td>
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<td>Johnson &amp; Easterling, 2012</td>
<td>Your child lived with a household member who served time in jail or prison</td>
<td>Children (Review of several studies)</td>
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<td>Review of Several Studies</td>
<td>Review of Several Studies</td>
<td>Children w/ incarcerated parents showed more risk for internalizing and externalizing</td>
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<tr>
<td>Study</td>
<td>Study Details</td>
<td>Participants &amp; Assessments</td>
<td>Findings</td>
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<tr>
<td>Rossman, 1998</td>
<td>Your child saw or heard household members hurt or threaten to hurt each other</td>
<td>Children (4-13 years)</td>
<td>PPVT, Santostefano’s Leveling/Sharpening Shootout, Theory of Mind Task</td>
<td>Verbal, Leveling/Sharpening, Theory of Mind</td>
<td>Witnessed domestic violence = sig lower PPVT and theory of mind. Witnessed domestic violence = sig higher leveling/sharpening skills.</td>
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<tr>
<td>Huth-Bocks, Levendosky, &amp; Semel, 2001</td>
<td>Your child saw or heard household members hurt or threaten to hurt each other</td>
<td>Children (3-5 years)</td>
<td>PPVT, Block Design (WPPSI)</td>
<td>Verbal, Spatial visualization and analysis</td>
<td>Witnessed Domestic Violence = significant lower cognitive functioning scores (just PPVT)</td>
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<tr>
<td>Sharkey (2010)</td>
<td>Your child often saw or heard violence in the neighborhood or in her/his school neighborhood</td>
<td>Child (5-17 yr.) Assessed 4 days, 7 days, 10 day, 14 days, and 28 days after a local homicide took place</td>
<td>WISC-R, Woodcock-Johnson Letter word task and applied problems.</td>
<td>IQ, reading, math, and writing.</td>
<td>Exposure to homicide = worse performance on all cognitive tasks.</td>
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<tr>
<td>Study</td>
<td>Description</td>
<td>Sample</td>
<td>Test</td>
<td>Abstract/Executive Functioning</td>
<td>Experience</td>
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<tr>
<td>Mills et al., 2010</td>
<td>A household member swore at, insulted, humiliated, or put down your child in a way that scared your child OR a household member acted in a way that made your child afraid that s/he might be physically hurt “Someone pushed, grabbed, slapped, or threw something at your child OR your child was hit so hard that your child was injured or had marks</td>
<td>Children (birth cohort and 14 yr.)</td>
<td>Raven’s Standard Progressive Matrices</td>
<td>Abstract reasoning (non-verbal intelligence)</td>
<td>Experience abuse/neglect= significantly lower RSPM scores</td>
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<tr>
<td>Gould et al., 2012</td>
<td>A household member swore at, insulted, humiliated, or put down your child in a way that scared your child OR a household member acted in a way that made your child afraid that s/he might be physically hurt “Someone pushed, grabbed, slapped, or threw something at your child OR your child was hit so hard that your child was injured or had marks</td>
<td>Adults (18-54) had experienced abuse/neglect in childhood</td>
<td>Cambridge Neuropsych Automated Testing Battery</td>
<td>Psychomotor coordination, Motor Speed, Reasoning and planning abilities, memory (pattern rec, spatial working mem, spatial rec mem), and attention (attention</td>
<td>Negative correlation between abuse and visual memory, executive functioning, and spatial working memory.</td>
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<tr>
<td>Study</td>
<td>Description</td>
<td>Sample</td>
<td>Test</td>
<td>Findings</td>
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<tr>
<td>Gould et al., 2012</td>
<td>Someone touched your child’s private parts or asked your child to touch their private parts in a sexual way</td>
<td>Adults (18-54) had experienced abuse/neglect in childhood</td>
<td>Cambridge Neuropsych Automated Testing Battery</td>
<td>Negative correlation between sexual abuse and executive functioning and spatial working memory.</td>
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<tr>
<td>Navalta et al., 2006</td>
<td>Someone touched your child’s private parts or asked your child to touch their private parts in a sexual way</td>
<td>College aged women had repeated sexual abuse in childhood</td>
<td>Memory Assessment Scale, CPT, self-report Scholastic Aptitude Test</td>
<td>Sexual abuse=significantly better scores in visual and global memory scales. More variability in reaction times on</td>
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</tr>
<tr>
<td>Authors, Year</td>
<td>Description</td>
<td>Age Group</td>
<td>Test</td>
<td>Measures</td>
<td>Findings</td>
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<tr>
<td>Gould et al., 2012</td>
<td>More than once, your child went without food, clothing, a place to live, or had no one to protect her/him</td>
<td>Adults (18-54) had experienced abuse/neglect in childhood</td>
<td>Y</td>
<td>Cambridge Neuropsych Automated Testing Battery</td>
<td>Psychomotor coordination, Motor Speed, Reasoning and planning abilities, memory (pattern rec, spatial working mem, spatial rec mem), and attention (attention shift and sustained attention) Negative correlation between physical forms of abuse/neglect and executive functioning, processing speed, and emotional processing.</td>
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<tr>
<td>Mills et al., 2010</td>
<td>More than once, your child went without food, clothing, a place to live, or had no one to protect her/him</td>
<td>Children (birth cohort and 14 yr.)</td>
<td>Y</td>
<td>Raven’s Standard Progressive Matrices</td>
<td>Abstract reasoning (non-verbal intelligence), Reading, Spelling and Arithmetic Experience abuse/neglect= sig lower WRAT and RSPM scores</td>
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<tr>
<td>Study</td>
<td>Description</td>
<td>Children</td>
<td>Y</td>
<td>Measured Constructs</td>
<td>IQ/PIaget Tasks</td>
<td>Other Constructs</td>
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<tr>
<td>Jacobsen et al., 1994</td>
<td>Your child often felt unsupported, unloved, and/or unprotected</td>
<td>Children (assessed at 7, 9, 12, 15, and 17)</td>
<td>Y</td>
<td>7 (Attachment, Self-Confidence, Piagetian cognitive tasks) 9 and 12</td>
<td></td>
<td>IQ, Piaget tasks of cog functioning, attention, self-confidence, perspective taking</td>
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<td></td>
<td></td>
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<td>15 (Piagetian cognitive tasks)</td>
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<td>17 (Piagetian Cognitive Tasks)</td>
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<tr>
<td>von der Lippe et al., 2010</td>
<td>Your child often felt unsupported, unloved, and/or unprotected</td>
<td>Children (assessed at 6-7 months, six yr. old)</td>
<td>Y</td>
<td>Infancy (maternal sensitivity index, strange situation procedure) 6 yr. old</td>
<td></td>
<td>Attachment, Maternal sensitivity, maternal verbal skills, child cog functioning</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>(Adult Attachment interview, Running Horses Game Test, Vocab test from WAIS, California Child Q-Set)</td>
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<td></td>
<td>Maternal secure attachment related to child's secure attachment, maternal sensitivity, and maternal decentered tutoring. Strong relation between maternal tutoring and child executive</td>
</tr>
<tr>
<td>Study</td>
<td>Sample Description</td>
<td>Participants</td>
<td>Setting</td>
<td>Measures</td>
<td>Findings</td>
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<tr>
<td>Lewis-Mortary et al. (2012)</td>
<td>Your child was in foster care</td>
<td>Children (4-6 years)</td>
<td>Y</td>
<td>Dimensional Change Card Sort Task</td>
<td>Cognitive flexibility</td>
<td></td>
</tr>
<tr>
<td>Fox &amp; Arcuri (1980)</td>
<td>Your child was in foster care</td>
<td>Children (4.11 yr. to 18 yr.), avg time in foster care=5.2 yrs. Avg age of placement=4.3 yrs.</td>
<td>N</td>
<td>WPPSI, WISC, and WAIS</td>
<td>Academic Achievement</td>
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<tr>
<td>Cassidy &amp; Taylor (2005)</td>
<td>Your child experienced harassment or bullying at school</td>
<td>Children (12-15 yrs.)</td>
<td>Y</td>
<td>Bully/Victim measure, Problem-Solving Inventory</td>
<td>Social cognition, problem solving</td>
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<tr>
<td>Rudolph, Troop-Gordon, and Flynn (2009)</td>
<td>Your child experienced harassment or bullying at school</td>
<td>Children (7-14 yrs.)</td>
<td>Y</td>
<td>Relational Victimization Task Self-Regulatory Processes (Dyadic Coding)</td>
<td>Behavioral and Emotional Regulatory Process, Social-</td>
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<tr>
<td>Allen &amp; Zigler (1986)</td>
<td>Your child had a serious medical procedure or life threatening illness</td>
<td>Child (5-10 yr.)</td>
<td>Y</td>
<td>PPVT</td>
<td>Cognitive Processes</td>
<td>Significant differences in cognitive functioning between two groups. Child w/ cancer performed worse on cognitive measures than healthy control. No diff for adjustment or other factors.</td>
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<tr>
<td>n/a</td>
<td>Child discriminated against based on race, religion, etc.</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>Little evidence to support that research has been conducted in this particular area.</td>
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<tr>
<td>n/a</td>
<td>Close family member w/ serious mental illness or attempted suicide</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>Little evidence to support that research has been conducted in this particular area.</td>
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<tr>
<td>n/a</td>
<td>Child Physically Assaulted</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>Little evidence to support that research has been conducted in this particular area.</td>
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<tr>
<td>n/a</td>
<td>Household member using/abusing drugs or alcohol</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>Little evidence to support that research has been conducted in this particular area.</td>
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<tr>
<td>n/a</td>
<td>Child lived w/ caregiver who died</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>Little evidence to support that research has been conducted in this particular area.</td>
</tr>
<tr>
<td>n/a</td>
<td>Child separated from caregiver due to immigration</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>Little evidence to support that research has been conducted in this particular area.</td>
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<tr>
<td>n/a</td>
<td>Your child experienced verbal or physical abuse or threats from a romantic partner (i.e., boyfriend or girlfriend)</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>Little evidence to support that research has been conducted in this particular area.</td>
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<tr>
<td>n/a</td>
<td>Your child was detained, arrested, or incarcerated</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>Little evidence to support that research has been conducted in this particular area.</td>
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