2015

CHILDHOOD MALTREATMENT AND ITS IMPACT ON EXECUTIVE SKILLS WITHIN AN INPATIENT SETTING

Jennifer Ann Dupont Frechette
University of Rhode Island, Jdupont@my.uri.edu

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BY

JENNIFER ANN DUPONT FRECHETTE

A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE

REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

IN

SCHOOL PSYCHOLOGY

UNIVERSITY OF RHODE ISLAND

201**5**

DOCTOR OF PHILOSOPHY IN SCHOOL PSYCHOLOGY

JENNIFER ANN DUPONT-FRECHETTE

APPROVED:

Dissertation Committee:

Susan Rattan

Charles Collyer

Theresa Deeney

Karen McCurdy

Nasser H. Zawia
DEAN OF THE GRADUATE SCHOOL

UNIVERSITY OF RHODE ISLAND
2015

ABSTRACT

Previous research has shown that child maltreatment can negatively impact brain development and neurocognitive systems for children, adolescents, and adults. However there are no published studies that have sought to understand the role of child maltreatment with psychiatrically hospitalized children. Psychiatrically hospitalized children are considered a high-risk population due to increased suicidality, internalizing disorders, and lower cognitive functioning. The current study examined a hierarchical and cumulative model of maltreatment with inpatient children (ages 6-14 years old) who had been maltreated (*n*=111) to understand its impact on executive functioning skills, compared with a psychiatric outpatient sample (*n*=166). Results using a hierarchical and cumulative model of maltreatment revealed that significant differences existed between the outpatient sample and children who had been maltreated on combined measures of general executive functioning, even after controlling for FSIQ. Group differences between the outpatient and inpatient samples were found for those who had been sexually and physically abused, but not neglected on general executive functioning skills using a hierarchical model of maltreatment. The cumulative model revealed significant differences between the control group and those who had been exposed to three and four types of maltreatment. Distinct neuropsychological profiles were related to the type of maltreatment and the number of maltreatment types the child had been exposed. Children who had been maltreated with PTSD significantly differed in their general executive functioning skills compared to the control group, however this difference no longer existed after controlling for FSIQ. Group differences were not found for those who had been

maltreated with or without PTSD. These findings extend previous research conducted with maltreated adolescents in an inpatient psychiatric setting, suggesting the type of maltreatment and number of maltreatment exposures, significantly impact different skills associated with executive functioning.

ACKNOWLEDGMENTS

I would first like to thank my major professor, Susan Rattan, who has been a solid source of support since day one of my graduate school career. She has guided me through difficult decisions and stressful periods of time, always with a smile on her face and a kind word to provide encouragement. I would also like to thank Charles Collyer who inspired me as an undergraduate student to further pursue my interests in psychology. His belief in me changed the way I viewed myself as a student and future psychologist, and for this I am eternally gratefully. I would like to express my gratitude to both Karen McCurdy and Theresa Deeney for their insights, support, and investment in this project. Margaret Rogers has been extraordinarily helpful over the course of my graduate studies, and I have the deepest respect for her. Additionally, this project would not have been possible without Karen Holler, who is a brilliant psychologist, wonderful mentor, and inspiring teacher.

I would not be here today without the patience and support of my family and friends. I would first like to express my gratitude to my husband. His patience, kindness, and humor have allowed me to get through some very difficult times. I am so lucky that I married my best friend who continually supports me throughout this roller coaster ride. I would also like to thank my parents who told me from when I was little girl that I could be whatever I wanted to be as long as I put my mind to it. Little did they know how much those words inspired and meant to me. Their support has meant the world to me. I would also like to thank Lindsay (my womb mate), Shelley, and my friends, who are still there for me despite the fact that I was rarely around the last five years. I promise to be more fun in the next five years. Lastly I would like to

thank my Memere, who started this journey with me, but left in the middle of it. She taught me to be tough, thoughtful with my words, and to give people the benefit of the doubt. Even though she is no longer here on earth, I am lucky enough to feel her presence and support everyday.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Every year over three million reports of child abuse are made in the United States, with one report being made every ten seconds (U.S. Department of Health and Human Services, 2013). The estimated costs associated with child maltreatment in the United States are staggering, averaging approximately $124 billion dollars per year (Fang, Brown, Florence, & Mercy, 2012). In 2012, nearly 3.8 million children were reported to child protective services, and of those referred, approximately 678,810 were confirmed victims of child abuse and neglect (U.S. Department of Health and Human Services, 2013). Moreover, 60% of children in the United States between the ages of two and seventeen have experienced or witnessed some form of violence within a one year time period (Finkelhor, Turner, Ormrod, & Hamby, 2009).

Children who are victims of maltreatment are at an increased risk for poor school performance (Jaffee & Maikovich-Fong, 2011; Jonson-Reid, Drake, Kim, Porterfield & Han, 2004; Perkins & Graham-Bermann, 2012), low self-esteem (Reynolds, Wallace, Hill, Weist, & Nabors, 2001; Shen, 2009), delinquency (Macmillan, 2009; Wisdom & Maxfield, 2001), social functioning deficits (Alink, Cicchetti, Kim, & Rogosch, 2012), substance abuse (De Bellis, 2002; Fetzner, McMillan, Sareen, & Asmundson, 2011; Ursano et al., 2009), mood disorders (Boxer & Terranova, 2008; De Bellis et al., 1999; Kavanaugh, Holler, & Selke, 2013), poor physical health (Lissau & Sorensen, 1994; Shin & Miller, 2012), and posttraumatic stress disorder (Anda et al., 2006; Fletcher, 1996; National Research Council [NRC],

2012). Additionally, evidence suggests that repeated stress and trauma that occurs during childhood can have damaging effects on brain development including neural network growth and the neuroendocrine systems that regulate these networks (Anda et al., 2006; Watts-English, Fortson, Gibler, Hooper, & De Bellis, 2006). These findings are consistent with a developmental psychopathology perspective that provides evidence for a linear trend associated with the deleterious effects of cumulative risk factors and poor outcomes for children who experience these co-occurring risk factors (Appleyard, Egeland, van Dulmen, & Sroufe, 2005).

Recent neuroimaging studies have discovered specific brain regions that appear to be particularly vulnerable to effects of childhood maltreatment, such as the hippocampus, amygdala, corpus callosum, and prefrontal cortex (Bellani, Nobile, Bianchi, van Os, & Brambilla; 2012; Carrion et al., 2009; Carrion & Wong, 2012; Karl et al., 2006; Teicher et al., 2003; Wilson, Hansen, & Li, 2011). Understanding the relationship between stressors associated with maltreatment in childhood and their effects on the developing brain is important because these brain abnormalities reflect deficits associated with learning, self-regulation, and psychopathology (Perkins & Graham-Bermann, 2012).

Researchers have recently begun to try to understand the relationship among child maltreatment, brain aberrations, and higher order cognitive functioning (Augusti & Melinder, 2013; Beers & De Bellis, 2002; De Bellis, Woolley, & Hooper, 2013; De Bellis, Hooper, Spratt, & Woolley, 2009; Kavanaugh & Holler, 2014; Kavanaugh et al., 2013; Nikulina & Widom, 2013). In particular, executive functioning deficits have been shown to be associated with childhood maltreatment within a community setting

for children ages five through seventeen (Augusti & Melinder, 2013; Beers & De Bellis, 2002; Bucker et al., 2012; De Bellis et al., 2013) and an adolescent psychiatric inpatient population (Kavanaugh & Holler, 2014). However, little is known about the impact of maltreatment on children within an inpatient psychiatric setting whose brains are still developing (De Young, Kenardy, & Cobham, 2011).

Children who have been victims of child maltreatment may be more likely to be hospitalized in a psychiatric setting due to these numerous risk factors, however the underlying neurocognitive functioning of these individuals remains largely unstudied within this setting (Kavanaugh & Holler, 2014). Understanding the impact of childhood maltreatment during middle childhood (ages 6-14 years) is pivotal in order to effectively develop strategies to best aid in the comprehensive treatment for these children. During middle childhood, cortical grey matter adapts, myelination continues within subcortical areas, and synaptic pruning continues (Mah & Ford-Jones, 2012). Furthermore, understanding the neuropsychological functioning of children who have been exposed to child maltreatment and the impact of PTSD associated with child maltreatment will provide researchers and clinicians with a better understanding of the child's current level of functioning compared to children who have not been exposed to maltreatment.

CHAPTER 2

REVIEW OF LITERATURE

Definition of Child Maltreatment

Many types of child maltreatment exist, including acts of emotional abuse, sexual abuse, physical abuse, and educational neglect, however consensus has not been reached as to which acts are considered under the umbrella term of 'maltreatment' and which are not. For example, the World Health Organization (2006) definition states:

> Child abuse or maltreatment constitutes all forms of physical and/or emotional ill treatment, sexual abuse, neglect or negligent treatment or commercial or other exploitation, resulting in actual or potential harm to the child's health, survival, development or dignity in the context of a relationship of responsibility, trust or power (p. 9).

This definition includes a wide range of behaviors or acts that may be considered maltreatment, whereas the United States Federal Government definition as amended by the Child Abuse Prevention and Treatment Act Reauthorization of 2010, defines child abuse and neglect more specifically as, "any recent act or failure to act on the part of a parent or caretaker which results in death, serious physical or emotional harm, sexual abuse or exploitation" or "an act or failure to act which presents an imminent risk of serious harm" (42 U.S.C.A. § 5106g). This definition provides a more definitive explanation as to which behaviors specifically are considered to be types of maltreatment, but may leave out specific sub-groups of children, such as those who have the potential to be harmed from these actions, but are not under imminent

risk. These differences have led to gaps in knowledge related to the definition, identification, and assessment of children who have been victims of maltreatment (NRC, 2012).

Four common types of maltreatment have been identified in various research studies, and include physical abuse (e.g., hitting, kicking, shaking or burning), sexual abuse (e.g., any sexual acts that occur with a child), emotional abuse (e.g., behaviors that negatively impact a child's emotional-wellbeing), and neglect (e.g., failure to meet a child's basic needs) (De Bellis et al., 1999; Johnson-Reid et al., 2004; Teicher, Durmont, Ito, Valtuzis, Gledd, & Andersen, 2004). Understanding the specific type of maltreatment is undoubtedly an important consideration when understanding its impact on cognitive functioning. For example, Nolin and Ethier (2007) sought to understand the neuropsychological profiles of children (ages 6 through 12) who have been neglected with and without physical abuse. The authors found that both of these groups differed from controls, where children who were neglected with physical abuse had cognitive deficits in auditory attention and response sets, visual motor-integration, problem-solving and planning. However, those who were neglected without physical abuse had a greater capacity for problem-solving, abstraction, and planning compared to both controls and those with a history of neglect and physical abuse.

Child Maltreatment and Brain Development

Many studies have demonstrated that some young children may be resilient to the negative effects of trauma (Agaibi, & Wilson, 2005; Carpenter & Stacks, 2009; Howell, 2001; Skopp, McDonald, Jouriles, & Rosenfield, 2007); however a large body of evidence suggests that young children may experience the detrimental effects of

trauma and incremental stress even more so compared to adolescents and adults (De Young, Cicchetti, & Rogosch, 2011). While there is not a lot known about higher order cognitive skills, including executive functioning, a related body of work suggests that maltreatment will negatively executive functioning and different forms of maltreatment may impact different components of executive functioning (De Bellis, 2001). Organizational developmental theory proposes that maltreatment that begins in early postnatal development and continues throughout early development puts children at the highest risk of poor social, behavioral, and cognitive outcomes (Cicchetti & Toth, 1995). Research has largely been conducted with adults with a history of maltreatment, and recent research has led to conflicting findings about the specific brain areas that are impacted by maltreatment for developing children**.**

Neurobiological and epidemiological research suggests that stress associated with maltreatment experienced in childhood can cause brain dysfunction and alter brain development resulting in a common pathway to a variety of behavioral, health, and social problems (Anda et al., 2006; Botteron, 2008; Carrion & Wong, 2012). Both animal and human studies suggest that chronic stress is associated with the release of glucocorticoids and the activation of the hypothalamus-pituitary-adrenal axis (Lupien, McEwen, Gunnar, & Heim, 2009; Lupien et al., 2005). When glucocorticoids are suppressed or elevated, brain development is impaired, suggesting a delicate balance between these systems for children whose brains are still developing (Lupien et al, 2009).

A recent review by Bellani and colleagues (2012) suggests that there is evidence for a genotype by environment interaction (G × E) that moderates the

developmental trajectory for brain functioning and behavioral outcomes for children who have been exposed to some form of childhood maltreatment. The gene-environment interaction may impact individual variations in one's reaction to stress associated with maltreatment and therefore, symptomology and behavioral outcomes (Alemany et al., 2011). For example, longitudinal studies suggest the neurotransmitter-metabolizing enzyme monoamine oxidase A (*MAOA*) plays a role in externalizing behaviors for individuals ages 3 through 25, whereas individuals with low *MAOA* activity genotype, who were exposed to childhood maltreatment, were more likely to exhibit antisocial behaviors (Caspi et al., 2002; Derringer, Krueger, Irons & Iacono, 2010). Furthermore, De Young et al. (2011) found that the *CRHR1* gene moderated the association between childhood maltreatment and neuroticism for children ages 8 through 13, which is a trait that is closely linked with most forms of psychopathology (Wallace & Newman, 1997).

These studies provide insight into the role of genetics, environmental factors, and behavioral outcomes associated with childhood maltreatment; however they do not consistently address the frequency, duration, developmental stage, and specific psychiatric symptomology associated with the type of maltreatment, or the physiologic changes that may occur (Bellani et al., 2012). Furthermore, various findings have implicated specific brain regions that are altered due to childhood maltreatment, most notably the corpus callosum, hippocampus, and prefrontal cortex, but have failed to reach consensus on how these brain regions are differentially affected.

Corpus Callosum

The corpus callosum is a midline brain structure that consists of a myelinated fiber tract connecting the right- and left-brain hemispheres, allowing communication between both of the hemispheres. The nerve fibers that connect both hemispheres are established prior to birth and are altered through experience-related pruning (Teicher et al., 2004). Increases in myelination occur dramatically at 6 months to 3 years of age and continue into young adulthood (De Bellis et al., 1999). Animal and human studies have shown that the corpus callosum may be highly susceptible to the impact of high-level stress hormones leading to effects on functioning (Carrion, Wong, & Kletter, 2012; De Bellis et al., 1999; Karl et al., 2006; Sánchez, Hearn, Do, Rilling, & Herndon, 1998; Teicher et al., 2003).

Sanchez and colleagues (1998) utilized high resolution magnetic resonance imaging (MRI) to understand the neural development and cognitive functioning of rhesus monkeys who were raised individually in a nursery from 2-12 months of age compared to those raised in a semi-naturalistic environment. The researchers discovered that those raised in more isolated environments had decreased cross-hemispheric projections and parietal and prefrontal white matter. The reduced number of cross-hemispheric projections was also related to the decreased size of the corpus callosum, which persisted for 6 months after being reintroduced to a more social environment. Additionally, the monkeys who were in socially deprived environments demonstrated cognitive deficits related to learning new information and object reversal learning. These findings are consistent with studies of children who have been raised

in institutional environments where little social interaction had occurred (Chugani et al., 2001).

Teicher and colleagues (2004) studied children (mean age=12.9 years) with a history of childhood abuse or neglect compared to healthy control participants using MRI. The results of this study found that boys who had a history of physical abuse, sexual abuse, or PTSD had marked reductions in the size of their corpus callosum. However, the impact of maltreatment on the corpus callosum for girls was much less pronounced, except for those with a history of sexual abuse. These findings were supported by De Bellis and colleagues (1999) who studied children with a history of maltreatment with PTSD and non-maltreated healthy controls ages 6 through 17. The authors found that those with a history of childhood maltreatment with PTSD had significantly smaller intracranial and cerebral volumes. Additionally, when SES and intracranial volume was controlled for, the corpus callosum remained smaller compared to control participants and was highly correlated with the duration of abuse.

Saltzman, Weems, Reiss, and Carrion (2006) also found that children (ages 7-14) with PTSD demonstrated mixed laterality compared to those who had been traumatized without PTSD symptomology, suggesting corpus callosum abnormalities are associated with PTSD symptomology. Furthermore, sex differences have been shown, where males with a history of maltreatment with PTSD had smaller corpus callosum areas compared to females with a similar history (De Bellis et al., 1999). De Bellis et al. (1999) hypothesized that males may be more vulnerable to the effects of acute stress on brain development associated with maltreatment compared to females. The effects of stress are most typically associated with other brain structures,

specifically the hippocampus, which is associated with hypothalamic–pituitary–adrenocortical functioning (Anda et al., 2006; Repetti, Taylor, & Seeman).

Hippocampus

One brain region that has been continually studied due to its critical role in learning, memory, and stress regulation is the hippocampus, which is a medial temporal brain structure (Carrion & Wong, 2012; Karl et al., 2006). The hippocampus is part of the limbic system, which also includes the amygdala and hypothalamus, and can be damaged by prolonged stress (Twardosz & Lutzker, 2010). The hippocampus contains glucocorticoid (cortisol) receptors that help stop the corticotrophin-releasing hormone that is activated in the hypothalamic-pituitary-adrenal (HPA) axis, which is related to arousal, anxiety, and hyper vigilance (Carrion et al., 2013; De Bellis et al., 1999; Twardosz & Lutzker, 2010). Studies have focused on both the volume of the hippocampus and the activation of this area during structured tasks for individuals who have been exposed to extreme stress in their childhood, including child maltreatment (Bremner, Randall, Vermetten, & Staib, 1997; Carrion, Haas, Garrett, Song, & Reiss, 2010; Carrion & Wong, 2012; Dannlowski et al., 2011). For example, two studies utilizing functional and structural magnetic resonance imagining have demonstrated that children ages 7 through 14 who have been subjected to childhood maltreatment had reduced hippocampal volumes and activity compared to controls (Carrion et al., 2010; Dannlowski et al., 2012). These findings are similar to studies conducted with adults with posttraumatic stress disorder (PTSD) resulting from childhood maltreatment (Bremmer et al., 1997; Villarreal et al., 2002). However, other studies have provided conflicting results suggesting no difference in hippocampal

volumes related to childhood maltreatment (Carrion et al., 2001; De Bellis et al., 2002). Moreover, Tupler and De Bellis (2006) reported that children and adolescents exposed to maltreatment had greater bilateral hippocampal volumes compared to controls, and hypothesized that developmental factors may account for differences between the child and adult studies.

In order to understand these differential findings, it is important to consider the function of brain plasticity. Brain development during the neonatal period is primarily controlled by gene expression and can be affected by the prenatal environment. At birth, the child has billions of neurons, however theses neuronal connections are weak. These connections are strengthened via experience-expectant development and experience-dependent development (Twardosz & Lutzker, 2010). Experience-expectant development pertains to the development of the brain based on *necessary* experiences that the brain requires for development to occur (Watling, Workman, & Bourne, 2012). Additionally, certain areas of the brain are more impacted by environmental factors. For example, compared to the brainstem, which is more functional at birth, the limbic system is more malleable and affected by one's environment (Joseph, 1999). Furthermore, certain periods of development are considered "critical" for infants' development, wherein certain situations such as deprivation and maltreatment, may inhibit developmental processes such as neurogenesis and myelination (Joseph, 1999; Teicher et al., 2003). If infants and young children are not exposed to sufficient stimulation at these critical junctures, then the establishment of neuronal connections may never occur or they may form abnormal interconnections (Joseph, 1999). For example, research has shown that there

is a ‘critical period’ (Joseph, 1999) for language acquisition; children who never are exposed to language at early ages have a far more difficult time acquiring basic speech abilities compared to those who are exposed to early enriched linguistic environments (Krashen, 1973).

Conversely, experience-dependent development is where neuronal connections are generated or modified based on one’s experiences. This development differs from experience-expectant development in that experience-dependent development is a process that occurs throughout the lifetime, whereas experience-expectant development generally is thought to end in early adulthood when pruning in the cerebral cortex stops (Twardosz & Lutzker, 2010). These differing environmental influences exert significant organizing effects on the brain, in particular, the hippocampus, and also impact facets of intelligence, social, and emotional development (Joseph, 1999). Joseph (1999) asserts:

> “Be it animal or human, similar deprivation-induced abnormalities affect the limbic system which may become emotionally and socially "blind" and unable to perceive, process, or respond in a normal fashion to social and emotional stimulation. Because various limbic neural assemblies require considerable social and emotional experience during specific developmental periods, and are thus "experience-expectant," they fail to fully develop or no longer function normally if deprived of that experience, even when "normal" experience is later provided” (p.192).

Hypothalamic–pituitary–adrenocortical (HPA) functioning may be particularly vulnerable to the effects of neglect and maltreatment for children (Repetti et al., 2002).

Whether it is a single traumatic event or continuous exposure to trauma, the physiological and behavioral responses related to these high stress events may have lasting effects on the brain's development (Milot, Ethier, St-Laurent, Provost, 2010). Most researchers agree that prolonged exposure to stress hormones can cause hippocampal atrophy, leading to lasting effects (Lupien et al., 2009). High levels of cortisol associated with trauma can be neurotoxic, and can be especially damaging to the hippocampus due to its high number of glucocorticoid receptors (Carrion et al., 2013). Additionally, research suggests that negative familial interactions, such as erratic attention from parents, are associated with abnormal glucocorticoid response profiles, weakened immunity, and increased illness (Flinn & England, 1997). Consistent with these findings, research has shown that a negative family environment can mediate a child's ability to form successful physiologic/neuroendocrine and/or behavioral responses to stress (Pace & Heim, 2011; Repetti et al., 2002).

Increased exposure to glucocorticoids has been shown to inhibit cytogenesis via the expression of brain-derived neurotropic factor (Harmelen et al., 2010). Interestingly, research has shown that neglect during childhood is related to increased secretion of glucocorticoid, whereas more severe trauma is associated with lower levels of glucocorticoid (Lupien et al., 2009). However, due to methodological inconsistencies, gender differences, and the fact that cortisol levels fluctuate naturally throughout the day, studies examining the role of cortisol for children exposed to maltreatment have been mixed (De Bellis, et al., 1999; 2002). While environmental factors play a key role in how the HPA axis is affected, the developmental time period that the trauma occurs and the duration of trauma can mediate these effects (Bellani et

al., 2012; Christopher, 2004; De Young et al., 2011b; Glaser, 2011; Horan & Widom, 2014; Lupien et al., 2009).

Lupien and colleague's (2009) life cycle model of stress is particularly helpful when trying to understand how the impact of stress is associated with maltreatment, and how this can impact brain regions differentially depending on the development period in which the trauma has occurred. The model demonstrates that from birth until the age of two, the hippocampus is more likely to be impacted by stress because it is undergoing rapid development. In contrast, the amygdala and prefrontal cortex may be more susceptible to stress in early childhood into adolescence because these brain structures are continuously developing until the late 20s, whereas the hippocampus is already fully organized (Lupien et al., 2009). Furthermore, the HPA-axis can become deregulated when excitatory neurotransmissions associated with stress do not decrease when the threat or stressor is removed (De Bellis et al., 2013; Wilson et al., 2001). The key brain structure referred to as the 'shut off valve' for this stress response in the HPA axis is the prefrontal cortex (Diorio, Viau, & Meaney, 1993; Wilson et al., 2011). Recent research has begun to show that while mild acute stress can cause detrimental effects, chronic stress may be even more damaging for the prefrontal cortex compared with other brain structures (Arnsten, 2009).

Prefrontal Cortex

The impact of maltreatment on the development of the prefrontal cortex may be most pertinent for preadolescent children because this brain region undergoes significant growth during this time period and becomes more efficient during middle childhood (Bauer, Lukowski, & Pathman, 2011; Cummings, 1993; Reiss, Abrams,

Singer, & Ross, 1996; Tekin & Cummings, 2002). The prefrontal cortex activates other brain regions such as the amygdala and hippocampus to respond to threats and stops excitatory neurotransmission to the hypothalamus-pituitary-adrenal axis, which is central to stress response activation (Wilson et al., 2011). It contains three large areas including dorsolateral prefrontal cortex which is involved in the cognition and control of behavior, and the orbitofrontal and medial prefrontal cortex which both play a role in emotion and social behavior (Pinel & Edwards, 2008). Furthermore, the dorsolateral prefrontal cortex undergoes significant development during middle childhood, and is associated with executive functioning, including the ability to generate word lists (fluency), copy figures, shift behavior, and recall recently learned information (Bauer et al., 2011; Tekin & Cummings, 2002). These abilities depend on strengthened neuronal connections that can be altered by changes in the neurochemical environment (Arnsten, 2009).

When stressful situations occur, the prefrontal cortex can become deregulated due to high levels of noradrenaline and dopamine triggered by the amygdala (Arnsten, 2009). The amygdala activates stress pathways in the hypothalamus and brainstem that inhibits the prefrontal cortex's ability to utilize top-down processes, such as attention and working memory, and permits bottom-up functioning that is associated with fight or flight responses (Arnsten, 2009; Botterton, 2008). When functioning properly, the prefrontal cortex allows individuals to inhibit classically conditioned fear responses (Botterton, 2008). For example, Buchanan et al. (2010) studied individuals with prefrontal cortex lesions, individuals with brain damage in other areas of the brain, and healthy controls' response to stressful situations. The researchers found that

individuals with damage to the medial prefrontal cortex had increased levels of cortisol and a greater affective response to stress compared to healthy controls and those with brain lesions in other areas of the brain (Buchanan et al., 2010). Furthermore, the researchers found that sex mediated the response to stress for males with damage in the medial prefrontal cortex, demonstrating a decreased cortisol response, and females showing an increased cortisol response. The authors suggest that this may be reflective of sex differences in the way the medial prefrontal cortex functions or variability as to the exact location of the brain damage (e.g. left hemisphere vs. right hemisphere) (Buchanan et al., 2010). Additionally, magnetic resonance imaging has shown children (ages 7-14) that have post-traumatic stress disorder resultant from trauma had frontal lobe abnormalities compared to healthy controls (Carrion et al., 2001).

Carrion et al. (2009) sought to understand brain morphology for twenty-four children, ages 7 through 14, who had been exposed to one or more traumatic event(s) and experienced post-traumatic stress disorder symptomology. Specifically, the authors used voxel-based and volumetric analyses using structural magnetic resonance imaging (sMRI) to elucidate differences in grey matter, white matter, and cerebrospinal fluid within the prefrontal cortex and midline brain structures. Results from the sMRI demonstrated that children with post-traumatic stress disorder symptomology had increased grey matter density and volume within all areas of the prefrontal cortex, which the authors hypothesized may reflect dysfunctional frontal lobe symptoms resultant from decreased pruning or increased arborization during development. De Bellis et al. (2001) reported that the age of onset of PTSD was

positively correlated with overall cerebral volume, while duration of PTSD trauma was negatively correlated to overall cerebral volume for children (ages 4-16) exposed to trauma, suggesting that childhood maltreatment experiences may adversely impact brain development. Despite these findings, research conducted with maltreated children has frequently disregarded other factors that impact structural brain changes.

The field of developmental traumatology is complex by nature. Many factors can influence brain development such as socioeconomic status, prenatal drug exposure, deprivation, nutrition, and educational experiences, thus making direct associations and assertions difficult. While most research conducted with maltreated children have studied structural brain abnormalities, few have studied neurobiological alterations via neurochemical analysis (De Bellis, Keshavan, Spencer & Hall, 2000). Neurochemical processes support the structural changes (e.g. myelination, dendritic aborization, axonal outgrowth) and biochemical outcomes required for proper neurotransmission and synaptic functioning (Blüml et al., 2013). Research using magnetic resonance spectroscopy revealed that the first 3 postnatal months of life are considered a "critical period" of rapid metabolic changes in the brain, wherein maltreatment during this time may cause alterations in normative brain development (Blüml et al., 2013). For example, De Bellis, Keshavan, Spencer and Hall (2000) studied *N*-acetylaspartate, which is an amino acid found in high concentrations within neurons, and is a marker of neuronal integrity (Chang et al., 2003).

Lower levels of *N*-acetylaspartate are associated with the injury and loss of neurons that are needed during development (Blüml et al., 2013). De Bellis et al. (2000) sought to understand the role of *N*-acetylaspartate for children (Mean age= 10

years old) who were diagnosed with PTSD secondary to maltreatment compared with healthy controls who were matched by age, sex, race, socioeconomic status, and Tanner stages of development. The authors utilized single voxel proton magnetic resonance spectroscopy and found lower levels of *N*-acetylaspartate within the medial prefrontal cortex region for participants with PTSD resultant from childhood maltreatment. These results suggest there may be alterations in brain functioning and regulation for children with PTSD due to maltreatment.

Functional magnetic resonance imaging (fMRI) has been used to understand the differences between children (mean age=13.7) with post-traumatic stress symptomology (PTSS), but do not meet formal diagnostic criteria, versus healthy controls matched by age and sex during a task of response inhibition (Carrion, Garrett, Menon, Weems, & Reiss, 2008). The use of fMRI allows one to understand how blood rushes to identified brain regions when they are being activated during specific tasks. Carrion et al. (2008) sought to understand if there were differences in the activation of prefrontal cortex for these children with PTSS versus a healthy-control group on a Go/No-Go task, which requires sustained attention and the ability to inhibit a prepotent response. While the two groups performed similarly on the Go/No-Go task, the control group demonstrated greater activation of the middle frontal cortex activation, while those with PTSS symptomology had greater medial frontal activation. These results suggest that the differential activation of specific brain regions during similar tasks for those children with PTSS symptomology may be due to previous research findings with children with PTSS demonstrating alterations from typical frontal lobe asymmetry (Carrion et al., 2001), reduced white matter in the

prefrontal cortex (De Bellis et al., 2002), and decreased left ventral and left inferior prefrontal gray matter volumes (Carrion et al., 2010). However, these results suggest that while brain activation may differ in how children with PTSS and healthy controls attempt the task, both groups are similar in their ability to complete the tasks, suggesting the brain may compensate using differential neural networks.

While much of the research has been conducted with children with PTSD or PTSS, a large proportion of children exposed to traumatic events never develop PTSD. Yehuda and LeDoux (2007) suggest that the effects of trauma do not necessarily lead to PTSD pathogenesis; rather they surmise that there is a specific phenotype for those who develop PTSD symptomology. Previous research has shown that differences have been found between those exposed to trauma with PTSD and those who have been exposed to trauma without PTSD in their verbal abilities (Saigh, Yasik, Oberfield, Halmandaris, & Bremner, 2006), while others have shown only nominal differences (De Bellis et al., 2009; Nikulina & Widom, 2013). Research suggests that a hypoactive prefrontal cortex may be seen as adaptive by allowing the amygdala to attend to a stimulus that was previously seen as threatening, but may be no longer threatening (Yehuda & LeDoux, 2007). Carrion, Wong, and Kletter (2013) asserts, "Impaired structure and function of the prefrontal cortex may confer specific stress vulnerabilities associated with the pathophysiology of PTSD and cognitive impairments in children" (p.55), and thus should be further understood.

Post-traumatic Stress Disorder

Post-traumatic stress disorder (PTSD) is defined as the exposure to actual or threated death, serious injury, or sexual violence either directly, by witnessing the

event, learning about traumatic events that have occurred to someone whom one is close with, or experiencing repeated exposure to traumatic events (American Psychiatric Association, 2013). According to *The Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; *DSM–5*; American Psychiatric Association, 2013) symptomology associated with the disorder includes recurrent and involuntary memories associated with a distressing event, recurrent unpleasant dreams that are related to the event, dissociative behaviors, avoidance of stimuli associated with the event, negative changes in cognition and mood, and alterations in arousal and reactivity that persists for more than one month (American Psychiatric Association, 2013). Prevalence rates of PTSD for adults range from 3.5% to 7.8%, with women being more likely to experience symptoms associated with PTSD compared to men (American Psychiatric Association, 2000, 2013; Gabbay, Oatis, Silva, & Hirsch, 2004), however less is known about the prevalence among children and adolescents.

Research has been mixed regarding the prevalence for children who have been diagnosed with PTSD due to childhood maltreatment, with rates varying from .05% to 88% of children (Copeland, Keeler, Angold, & Costello, 2007; Perkonigg, Kessler, Storz, & Wittchen, 2000). This wide variability may be due to methodological problems, the use of retrospective reports, the different types of childhood maltreatment that have been included, and the lack of heterogeneity of participants. For example, results from a nationally representative sample of 10,000 adolescents 13 to 18 years of age found that approximately 5% of adolescents had met criteria for PTSD (Merikangas et al., 2010). Furthermore, these findings suggest that PTSD was more prevalent in females, with modest increases in age, which is similar to research

with adults (American Psychiatric Association, 2000, 2013; Merikangas et al., 2010). Females may be more resilient to the effects of PTSD as a result of child maltreatment as evidenced by decreased corpus callosum volume and smaller cerebral volume for maltreated males with PTSD compared to females (De Bellis et al., 1999).

Graham-Bermann, DeVoe, Mattis, Lynch, and Thomas (2006) sought to understand the prevalence of children ages 5 through 13 who were exposed to intimate partner violence and found that 33% of Caucasian children and 17% of minority children were diagnosed with PTSD. Whereas Boxer and Terranova (2008) found that 8% of ethnically diverse children ages 10-17 within an inpatient psychiatric setting who were maltreated (sexual abuse, physical abuse, neglect, emotional abuse) met criteria for PTSD. While there is a lack of consensus regarding prevalence of children diagnosed with PTSD due to childhood maltreatment, research has shown that children may be less resilient to the impact of trauma compared with adults (De Bellis, 2001). Children are exposed to greater violence, abuse, and crime compared to adults (Finkelhor et al., 2009). The amount of exposure may vary due to contextual variables (e.g. inner city settings), cultural group affiliation, and developmental factors (American Psychiatric Association, 2013; Blanco, 2011). Other risk factors associated with PTSD include previous trauma exposures, psychopathology, subtle executive functioning impairments, low social support, and parental psychopathology (Aupperle, Melrose, Stein, & Paulus, 2012; De Bellis, 2001; Hamblen & Barnett, 2014). De Bellis (2001) asserts that children who do not develop PTSD are less likely to develop psychopathology, however those that do experience PTSD symptomology are at an increased risk of developing other psychopathological disorders.

Beers and De Bellis (2002) sought to understand the role of PTSD on neuropsychological functioning for children (mean age= 11.38 years) exposed to maltreatment within an outpatient psychiatric setting compared to controls (mean age=12.17) similar in age, race, socioeconomic status, and IQ. Within this sample, the children with PTSD had been exposed to sexual abuse, physical abuse, or witnessing domestic violence. The authors reported that children with PTSD secondary to maltreatment performed significantly lower on measures of attention, abstract reasoning, learning and memory, and visual-spatial functioning. However there were no differences found on tests of language or psychomotor speed. While this study provides insight into how executive functions may be compromised due to maltreatment with PTSD, the study's small sample size (children with PTSD= 14; control participants=15), and lack of a comparison group without PTSD diagnosis suggests caution is warranted in generalizing these results to children exposed to maltreatment with PTSD.

Child Maltreatment and Executive Functioning

Executive skills develop shortly after birth and become more refined during adolescence and early adulthood (Center on the Developing Child, 2011). During the ages of 3 through 5, children experience the most dramatic growth of skills related to executive functioning, however the development of these skills can be altered through experiences and extreme stress (Center on the Developing Child, 2011). Anderson, Levin and Jacobs (2002) assert that while frontal regions of the brain (e.g. prefrontal cortex) may play an important role in the mediation of executive functions, the integrity of the entire brain is influential in performance. The prefrontal cortex has

extensive connections with other areas of the brain including the limbic system, basal ganglia, thalamus, hippocampus and other brain structures (Ardila, 2012).

Due to the findings that have demonstrated that executive functions involve multiple distributed neural networks, it is difficult for researchers to conclude the basic functions associated with executive functions (Titz & Karbach, 2014). This had led to much debate as to which definitions, skills, and mental functions qualify as executive functions, and which do not. For example, Mangeot, Armstrong, Colvin, Yeates, & Taylor's (2002) definition refers to executive functions as "a generic term that refers to a variety of different capacities that enable purposeful, goal-directed behavior, including behavior regulation, working memory, planning, organizational skills, and self-monitoring" (as cited in Stuss & Benton, 1986, p. 272). Friedman and colleagues (2007) provide a general definition including "a family of cognitive control processes that operate on lower-level processes to regulate and shape behavior" (p. 893). Willcutt, Doyle, Nigg, Faraone, and Pennington (2005) explain "executive functions represent 'top-down' cognitive inputs that facilitate decision-making by maintaining information about possible choices in working memory and integrating this knowledge with information about the current context to identify the optimal action for the situation" (p. 1336). While most definitions of executive functioning include the ability to self-regulate in order to achieve goals (Barkley, 2012), past research conducted with children have only included global measures of IQ or a few specific executive functioning domains, leading to inconclusive findings (De Bellis et al., 2013).

Executive function skills are considered the critical building blocks in the development of cognitive and social skills (Center on the Developing Child, 2011). DePrince, Weinzierl and Combs (2009) sought to understand the role of familial trauma (e.g., sexual or physical victimization or witnessing domestic violence), and non-familial trauma (e.g., natural disaster), on executive functioning for children (mean age= 10.39; SD=1.19) in a community sample compared to healthy controls. The researchers discovered that after controlling for anxiety, socioeconomic status, dissociation symptoms and potential traumatic brain injury, only familial-trauma-exposure status and disassociation symptomology contributed unique variance to executive functioning performance, whereas non-familial trauma was not related to current level of executive functioning (DePrince et al., 2009). These findings were replicated by Bucker and colleagues (2012), however this study included children ages 5 through 12 who were exposed to child maltreatment early in life (trauma before the age of four) who were matched with healthy controls (no history of maltreatment) by their sex and age. The researchers found that the children exposed to early traumatic experiences performed significantly lower on attention and working memory tasks compared to the age- and sex-matched control group.

It is important to note that given the diverse nature of executive functions, it may be important to learn if specific executive functions are more highly affected than others due to the stress associated with childhood maltreatment. Augusti and Melinder (2013) sought to address this gap in the research for children within a community sample, ages 8 through 12, who were matched with a healthy control based on age and IQ. The authors reported no differences between those children who have been

maltreated on a measure of inhibition, however there was a significant difference between groups on a spatial working memory task. The authors argue that the strategies used for working memory may be more afflicted by stress than inhibition tasks (Augusti & Melinder, 2013). Kirke-Smith, Henry, and Messer (2014) found that maltreated adolescents performed significantly lower on measures of working memory, fluency, and inhibition. While these studies provides insight into the differential executive skills that may be impacted by childhood maltreatment, they have numerous limitations including small sample sizes, the inclusion of unsubstantiated accounts, and limited measures associated with executive functioning respectively.

The time period in which child maltreatment occurs and the length of its frequency is an important facet to understand due to the varying impact of different types of maltreatment and its chronicity. Jaffee and Maikovich-Fong (2011) studied the effects of chronic maltreatment on developmental outcomes for children from birth to age nine, using data from the National Survey of Child and Adolescent Well-Being. The sample consisted of 1,777 children (mean age= 2.9 years) from diverse racial backgrounds, who were interviewed at five points (2-6 months; 12 months; 18 months; 36 months; 59-96 months) in the time following the documented maltreatment. The authors defined situational maltreatment as occurring in only one developmental period according to Erikson's stages of psychosocial development (Erikson, 1963); whereas two developmental periods was defined as limited. Approximately 12% of children within this study fell within the extensive maltreatment category defined as children who were maltreated in three or four

developmental periods. The researchers utilized ordinary least squares regression analyses and reported that children who were more chronically maltreated reported higher levels of externalizing and internalizing problems, and had lower IQ scores compared to those who had been maltreated in only one developmental time period. However, the researchers discovered that those who fell within the limited and extensive maltreatment groups were similar in nature, thus reflecting difficulty in measuring the differential impacts of maltreatment based on developmental periods. This was further supported by the researchers' findings suggesting that the age in which the maltreatment began (e.g. infancy vs. later developmental period), did not predict child outcomes (Jaffee & Maikovich-Fong, 2011).

To further understand the long-term impacts of child maltreatment, Nikulina and Widom (2013) conducted a prospective study on the long-term impact of physical abuse, sexual abuse, and neglect on executive functioning. Participants included children in infancy to eleven years of age who had court substantiated abuse and neglect cases, who were matched based with a non-maltreated healthy control based on age, sex, race/ethnicity, and social class at the time of abuse occurrence. All participants were assessed at 41 years of age on measures of cognitive flexibility, processing speed, nonverbal reasoning, and IQ. The researchers found that adults who had been neglected as children performed significantly lower on measures of executive functioning and nonverbal abilities compared to those who had experienced sexual abuse, physical abuse, and control participants. These results remained after controlling for demographic characteristics, IQ, depressive symptomology and excessive alcohol use. Furthermore these results were not mediated or moderated by

PTSD diagnoses. These findings provide support for experience-expected development, suggesting the lack of enrichment opportunities for children subject to neglect during critical periods of brain development may inhibit these skills and neural connections from forming. These results are further substantiated by research with children adopted from deprived physical and psychosocial institutions (Merz, McCall, & Groza, 2013).

Pears, Kim, and Fisher (2008) chose to study childhood maltreatment by identifying subgroups of pre-school aged children based on severity of maltreatment and the type that occurred using latent profile analysis. The authors advocated for the need to include the multidimensional aspects of childhood maltreatment, including severity, instead of assigning a child who has been exposed to multiple types of maltreatment to just one category. This approach was supported by Lau et al. (2005) who identified different classification schemes (e.g. hierarchical, severity/frequency, expanded categories), and found that the expanded classification type, which included different types of maltreatment that the child had been exposed, was the most robust predictor of outcomes. Pears et al. (2008) discovered four basic profiles that were categorized as "supervisory neglect/emotional maltreatment," "sexual abuse/emotional maltreatment/neglect," "physical abuse/emotional maltreatment/neglect," and "sexual abuse/physical abuse/emotional maltreatment/neglect." The authors found that children who fell under "sexual abuse/physical abuse/emotional maltreatment/neglect" had the highest risk for externalizing problems, internalizing problems, and poor cognitive functioning. Additionally, the authors reported that these maltreatment

profiles were related to differential emotional and cognitive outcomes, suggesting that combinations of maltreatment may lead to specific behavioral and cognitive sequelae.

These recent studies have found that child maltreatment is associated with core executive deficits within a community child population (ages 5-17) (Augusti & Melinder, 2013; Beers & De Bellis, 2002; Bucker et al., 2012; De Bellis et al., 2013), however less is known about the executive functions that are impacted for children in a psychiatric in-patient setting (Boxer & Terranova, 2008). The in-patient population is considered a high-risk group for long-term psychological impairments, with higher rates of maltreatment compared to non-clinical subgroups (Boxer & Terranova, 2008; Day, Franklin, & Marshall, 1998; Sullivan, Fehon, Andres-Hyman, Lipschitz, & Grilo, 2006). Thus, understanding the role of childhood maltreatment within an inpatient setting is needed.

Child Maltreatment and Executive Functioning Within an Inpatient Setting

Currently, there have only been a few studies that have explored the impact of childhood maltreatment for children (Boxer & Terranova, 2008) and adolescents (Grilo, Sanislow, Fehon, Martino, & McGlashan, 1999; Kavanaugh et al., 2013; Sullivan et al., 2006) within an in-patient psychiatric setting. Furthermore, only one study has analyzed the relationship between child maltreatment and executive functioning within an inpatient setting with adolescents (Kavanaugh et al., 2013). Research has shown that adolescents within an inpatient psychiatric hospital with a history of childhood maltreatment demonstrate higher levels of suicidality, violence, and impulsivity compared to those without a history of childhood maltreatment (Grilo

et al., 1999). Additionally, approximately 23% of inpatient adolescents met PTSD criteria (Lipschitz, Grilo, Fehon, McGlashan, & Southwick, 2000).

Boxer and Terranova (2008) studied the impact of child maltreatment for individuals, ages 10-17, within an inpatient psychiatric setting. Similar to prior studies (Lau et al., 2005; Pears et al., 2008), Boxer and Terranova utilized three difference classification systems of maltreatment to understand how these classifications result in overall psychopathology. The authors used a hierarchically ordered model of maltreatment, a cumulative model, and an independent model. The results from this analysis supported the use of both a hierarchical and cumulative model. The hierarchical model is based on a theoretical orientation suggesting that sexual abuse is considered the "worst" because it breaks highly valued social norms, followed by physical abuse, and then neglect (Boxer & Terranova; Lau et al., 2005).

The cumulative model aligns well with developmental psychopathology theory, where the higher number of forms of maltreatment the child has been subject to is related to higher risk of internalizing, externalizing, and general psychopathology. The researchers reported that sexual abuse was correlated with higher levels of internalizing problems and overall psychopathology, compared to physical abuse and neglect using both hierarchical and cumulative risk models. It is important to note that while hierarchical coding systems are frequently used in decision-making for child protective service purposes and within the literature, there are currently no theoretical orientations supporting this framework (Lau et al., 2005). These results suggest that differential ways of defining child maltreatment can lead to

a variety of outcomes, and cautions one in generalizing findings due to the diverse ways in which child maltreatment has been conceptualized.

Kavanaugh and colleagues (2013) sought to understand the neuropsychological presentation of an inpatient adolescent population (ages 13-19) based on their exposure to specific types of child maltreatment. The sample consisted of individuals with a history of maltreatment (n=49), and those with no maltreatment history (n=73). Using retrospective chart reviews, the researchers analyzed the effects of maltreatment on executive functioning, language abilities, and measures of self-reported depression and anxiety symptomology. Consistent with prior research (Augusti & Melinder, 2013; Beers & De Bellis, 2002; De Bellis et al., 2009; DePrince et al., 2009; Nolin & Ethier, 2007) maltreated inpatients scored lower on measures of executive functioning and higher on measures of anxiety and depression. Furthermore, the researchers discovered that emotional abuse was negatively correlated with working memory/simple attention, whereas physical and sexual abuse were associated with deficits in cognitive flexibility/set shifting and problem solving/planning. Moreover, the researchers found that sexual abuse was correlated with deficits in expressive and receptive language abilities, but was not related to physical abuse, emotional abuse, or neglect. These findings support previous research suggesting the heterogeneity of neuropsychological deficits in children based on the different types of maltreatment of which they have been exposed (Nolin & Ethier, 2007).

The present study sought to address this gap in the research and extend upon Kavanaugh et al.'s research (2013) related to child maltreatment and executive functioning for children ages 6-14 within an inpatient psychiatric hospital setting. To

this researcher's knowledge, this is the first study to analyze the effect of child maltreatment on executive functioning skills for children within an inpatient psychiatric setting. Due to the research that demonstrates that inpatient adolescents are at an increased risk for higher rates of psychopathology and less developed executive functioning skills, it is important to understand the risk factors associated with younger individuals. Furthermore, younger individuals may demonstrate variability in their executive functioning abilities compared to adults and adolescents because their brains are still rapidly developing. Understanding the risk factors associated with child maltreatment and its impact on executive functioning skills will provide clinicians, psychologists, and educators' important information regarding their higher order cognitive abilities and will allow for interventions to be put in place that will strengthen these executive functioning abilities.

A secondary purpose of this study compared children who have been exposed to child maltreatment with PTSD, child maltreatment without PTSD, and a control comparison group (outpatient group) on their executive functioning. Previous research has shown that differences have been found between those exposed to trauma with PTSD and those who have been exposed to trauma without PTSD in their verbal abilities (Saigh et. al., 2006), while others have shown only nominal differences (De Bellis et al., 2009; Nikulina & Widom, 2013). This study will seek to further understand the differences between these groups and learn if different types of trauma are related to specific deficits in executive functioning. The following questions are addressed in the present study:

1. *Executive Functioning.* This study examined the neuropsychological profile of childhood maltreatment within a child inpatient sample. It was hypothesized that children within an inpatient setting exposed to childhood maltreatment would have significantly more impairments in their executive functioning compared to the control group (e.g., outpatient and no maltreatment group).
2. *Post-Traumatic Stress Disorder.* This research sought to uncover characteristics associated with children of maltreatment compared to those with both PTSD and maltreatment within an inpatient setting, and controls (i.e. no history of maltreatment). It was hypothesized that the childhood maltreatment with PTSD group will have significantly more impairments in their executive functioning compared to controls and childhood maltreatment without PTSD groups.
3. *Specific Executive Functioning Skills*. The current study examined the specific higher order cognitive functions associated with childhood maltreatment within the inpatient population. It was hypothesized that specific executive functions are related to the type of trauma to which the child was exposed.
4. *Defining Maltreatment*. This study sought to understand if using a hierarchical or cumulative model of maltreatment best predicted executive functioning outcomes. It was hypothesized that children exposed to different types of maltreatment will have lower scores on measures of executive functioning compared to individuals exposed to

one type of maltreatment. Additionally, it was hypothesized that the specific types of maltreatment will be related to differential executive skills.

CHAPTER 3

METHODOLOGY

The Institutional Review Boards at the University of Rhode Island and Lifespan Hospital approved this study in September 2014 and October 2014, respectively, prior to data collection. Informed consent was waived because all data was collected via retrospective chart review.

The present study was conducted in the context of the Bradley Hospital Children's Inpatient Unit Research Project. The Bradley Hospital Children's Inpatient Unit Research Project is a project that seeks to examine the neuropsychological correlates of psychiatric conditions, social-emotional variables, and risk/protective factors leading to positive outcomes for children hospitalized due to psychiatric safety concerns. Data were gathered by retrospective chart reviews for inpatient and outpatient children (ages 6-14) who participated in a neuropsychological assessment between the years 2010 to 2014. During hospital intake, primary clinicians gather detailed information regarding behavioral concerns, current stressors, and developmental history. Neuropsychological evaluations were typically completed within a few days of hospital admission and were completed due to requests from an attending psychiatrist and/or parent/guardian concerns. A clinical child neuropsychologist, a professional psychometrist, or a doctoral student in clinical psychology under direct supervision of a child neuropsychologist conducted all neuropsychological/psychological assessments. Testing sessions generally range from 45 minutes to 1½ hours and are normally conducted in one sitting. All assessments

are completed in a private room within the inpatient setting. A total of 198 inpatient participants' data were entered into the master database.

Participants

The outpatient sample consisted of children who received comprehensive neuropsychological assessments by a clinical neuropsychologist from NeuroPsychology Associates, Inc. NeuroPsychology Associates, Inc. specializes in the neuropsychological and psychological evaluation and diagnosis of children, adolescents, and adults. Children were referred for a variety of reasons including attentional issues, learning difficulties, and emotional regulation problems. Additionally, various school systems referred students for assessment to help aid in educational planning. Parents and children completed paperwork that included questions regarding developmental history, educational progress, and current psychological concerns. Data were entered from 200 outpatient charts; this was the control data.

Eligibility Requirements. All children ages 6 through 14 years old who received neuropsychological testing were included in the present study. For the inpatient setting, children with a history of childhood maltreatment were included, resulting in 111 participants. Children were excluded from the present sample if their FSIQ < 70; or if they had a history of significant medical illness, head injury, or neurological disorder; or if they had a diagnosis of schizophrenia, anorexia nervosa, pervasive developmental disorder or psychosis. Participants from the outpatient sample were included if they had no history of maltreatment and met all other

inclusionary criteria. A total of 166 outpatient participants were included, leaving the total sample size of 277.

Participants. The inpatient sample consisted of 37 girls (33%) and 74 boys (67%) with an average age of 9.85 years (SD=1.95) (see Table 1). Table 2 presents demographic information for this sample. English was the primary language spoken by the children (98%) and by their families (95%). The outpatient sample consisted of 66 females (40%) and 100 males (60%) with an average age of 9.94 years (SD=2.25) (see Table 1). The majority of the outpatient group was Caucasian (see Table 3). English was the primary language spoken by the child (97%) and their family (94%).

Table 1

Age Frequencies for the Inpatient and Outpatient Sample

Age in Years-Inpatient	Percentage-Inpatient	Age in Years-Outpatient	Percentage-Outpatient
6	3.6%	6	4.8%
7	9.9%	7	13.3%
8	14.4%	8	12.1%
9	18%	9	10.9%
10	10.8%	10	15.7%
11	13.5%	11	15.7%
12	22.5%	12	12.1%
13	7.2%	13	5.4%

Table 2

Demographic Information from the Inpatient Participants

Race/Ethnicity	**N**	**Percentage**
Caucasian	49	63.8%
Hispanic	18	10.3%
Not Reported	18	10.3%
Two or More Races	14	8.0%
African American	10	5.7%
Asian	2	1.1%

Table 3

Demographic Information from the Outpatient Participants

Race/Ethnicity	**N**	**Percentage**
Caucasian	138	88.5%
African American	11	7.1%
Not Reported	10	6.2%
Hispanic	5	8.2%
Asian	2	1.2%

Parent/guardian employment status was not consistently obtained, however of those collected (n=66) approximately 61% of mothers were employed and 10% had income from two working parents/guardians. Prior to hospitalization, children lived in a variety of settings, including with their biological parents, foster families, adoptive parents, and residential settings (see Table 4). Approximately 75% of the outpatient

children resided with their married parents (see Table 5). Within the outpatient sample, 78% of both parents were employed, 20% had income from only one parent, and 2% did not report their employment history.

Table 4

Living Environment Prior to Hospitalization

Head of Household	**N**	**Percentage**
Mother	42	39%
Mother and Step-Parent	13	12%
Residential Setting	13	12%
Biological Mother and Biological Father	12	11%
Adoptive Family	8	7%
Foster Family	6	6%
Grandparents	5	5%
Father	5	5%
Father and Step-Parent	1	1%
Other Relative	1	1%
Homeless Shelter (with parents)	1	1%

Table 5

Living Environment for the Outpatient Group

Head of Household	**N**	**Percentage**
Biological Mother and Biological Father	124	75%
Mother	24	15%
Unknown	14	8%
Shared Custody	5	3%
Father	1	0.01%
Grandparents	1	0.01%

Due to the lack of information representing each participant's socioeconomic status within the inpatient sample, each child's school, zip code, and insurance type was researched. Each school's percentage of free and reduced lunch students was obtained (see Figure 1). Zip codes were researched and each community's median income was noted. The mean household income (based on zip code) was $40,193 (*Range*= $14,095 - $84,583). All insurance information was collected and was entered to provide information regarding socioeconomic status. For example, those who had state provided insurance met eligibility requirements for that type of insurance, which requires each family's income to be less than 250% of the Federal Poverty Level. Table 6 provides an overview of the insurance providers for the inpatient sample. NeuroPsychology Associates primarily accepts Blue Cross Blue Shield insurance, thus approximately 87% of the outpatient participants were insured through Blue Cross Blue Shield. Table 7 provides an overview of the parent's educational history for the outpatient group. This information was not collected for the inpatient sample.

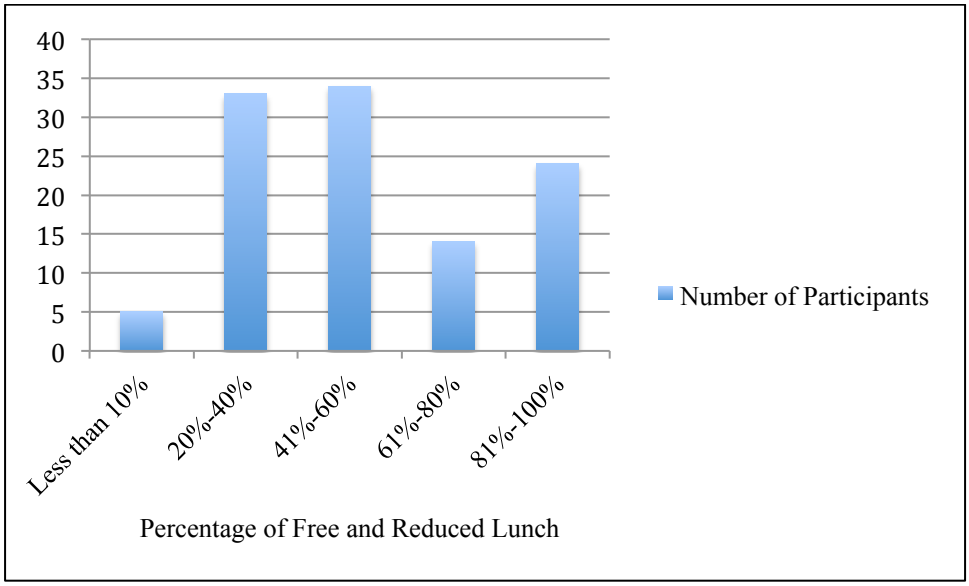

Figure 1. School's Free and Reduced Lunch Percentage for the Inpatient Group

Table 6

Inpatient Insurance Providers

Insurance Type	**N**	**Percentage**
Neighborhood Health Plan	59	56%
Rite Care	15	14%
Blue Cross	12	11%
Medicaid	12	11%
School Paid	3	3%
Harvard Behavioral	2	2%
Boston Medical	1	1%
Health Plan Inc.	1	1%
Tufts	1	1%

Table 7

Outpatient Parents' Educational Background

Mother's Highest Educational Level	Percentage	Father's Highest Educational Level	Percentage
Less than High School	6.3%	Less than High School	2.7%
High School	6.9%	High School	24.3%
Some College	8.8%	Some College	4.8%
Associates/Professional Degree	4.4%	Associates/Professional Degree	8.1%
Bachelors Degree	39.8%	Bachelors Degree	32.1%
Masters Degree	28.4%	Masters Degree/MBA	12.5%
PhD/MD/Law Degree	8.8%	PhD/MD/Law Degree	13.9%

Information regarding each child's school and educational placement was collected. Within the inpatient population, 78% of students were within a regular education setting, 6% were within a self-contained classroom, and 12% attended a specialized school. Over half of students had an Individualized Education Plan already in place within their educational setting. Ninety-one percent of children within the inpatient setting had a family history of a psychiatric illness, and 96% of children admitted to the hospital had a prior psychological or neurocognitive diagnosis. Of the inpatient participants, approximately 32% had been previously hospitalized on a psychiatric hospital in-patient unit. Within the outpatient sample, approximately 84% had a family history of a learning, psychiatric, or substance abuse problem. Of the outpatient children, 97% of children were in regular education settings.

Procedure

The Bradley Hospital Children's Inpatient Unit Research Project is directed and supervised by Dr. Karen Holler. Dr. Holler is the lead neuropsychologist on the

Child Inpatient Unit at Bradley Hospital, Brown University Associate Professor, and co-owner of NeuroPsychology Associates Inc. The Bradley Hospital Children's Inpatient Unit Research team consists of one post-doctoral clinical psychology student, three psychology doctoral students (including the author), and one research assistant. The research team met bi-weekly for supervision by Dr. Holler.

Data collection began in September 2014 and continued until January 2015. Data were entered into an encrypted Excel spreadsheet. All research team members were trained by the author on data entry, IRB guidelines, and how to address questions/concerns. The outpatient data were entered by the student researcher and a doctoral clinical psychology student. Questions regarding patient variables were highlighted and then discussed with team members and during supervision until 100% agreement was met. Developmental questionnaires provided information about each child's medical, psychological, family, and educational backgrounds. Neuropsychological scores were gathered by review of a master score sheet. Scaled scores, standard scores, t-scores, and raw scores were entered and later transformed to z-scores.

Inpatient data were entered by the student researcher, two doctoral students, and the research assistant. All information aside from neuropsychological test data was gathered by Lifespan's online medical records database. Paper charts were scanned into the database and all information regarding prior hospitalizations was located within the online database. Information was gathered from the intake summary, discharge summary, self-report measures, and neuropsychological reports. Data from 2010-2011 were not consistently entered into the database. Patients'

medical charts from 2011 were located in a locked medical chart storage center at Bradley Hospital. Patient charts from 2010 were requested from the medical storage unit located off hospital premises.

Neuropsychological test scores from 2014 were gathered from psychological testing charts located at Bradley Hospital. All testing protocols were included within each file. Participants' neuropsychological testing scores from 2010-2013 were requested within two waves from a storage center located off of the hospital premises. Scores were not consistently reported for all assessments and a doctoral psychology student was responsible for the recalculations of scores based on each test's normative data. Tests administered were cross-referenced with the neuropsychological report to ensure all neuropsychological data were entered. Charts were randomly chosen to ensure accurate score calculations. Additionally, all assessments that were administered on a hospital laptop was accessed and provided scored reports for specific tests. Participants with questionable medical history (e.g. brain damage, pervasive developmental disorder) were then identified and excluded from the data set.

Measures

Demographics.

All participants' demographic information was collected via retrospective chart review of the intake report, neuropsychological evaluation, and discharge summary.

Age. Participants' age was calculated at the age of the neuropsychological evaluation in months.

Sex. Participants' sex was gathered from their patient charts.

Race/ethnicity. Participants' race/ethnicity was gathered through chart review or as indicated in the neuropsychological report.

School/Grade. Participants' school and grade level was gathered to learn more about their educational setting and if their placement was out of district.

Employment Status. Parents' employment status was gathered by intake summary within the inpatient sample and family questionnaire within the outpatient setting.

Current Family Environment. Information about the child's placement and living situation was gathered from neuropsychological report and intake summaries.

Family History of Psychiatric/Substance/Learning Disorders. The outpatient sample consistently documented in-depth family history of psychiatric, substance and learning disorders. The inpatient sample was less consistent in providing this information.

Socioeconomic Status. The information collected for Socioeconomic Status (SES) differed for the outpatient and inpatient groups and is a limitation of the present study. The only similar variable that was reported consistently in both samples was insurance type. The type of insurance was collected for all participants. The type of insurance was used to indicate socioeconomic status for the inpatient and outpatient population (e.g. state assistance, low-income insurance requirements met, and private insurance).

Intake Diagnosis. Each participant's psychological diagnostic history was gathered by review of the neuropsychological evaluation. Participants within the

inpatient unit were consistently provided preliminary diagnoses based on the intake information if they did not previously have a psychological diagnosis.

Academic Environment/Special Education Status. Information regarding educational history, special education status, and classroom setting was gathered to provide further understanding of each participant's educational background and level of academic supports.

Executive Functioning. The following executive function domains are based on a review of pediatric and child neuropsychological literature and include: (a) Planning/Problem-Solving, (b) Set Shifting/Cognitive Flexibility, (c) Response Inhibition/Interference Control, (d) Fluency, and (e) Working Memory/Simple Attention. Each neuropsychological assessment was categorized based on Baron (2004) and Kavanaugh et al.'s (2013) recommendations.

Planning/Problem-Solving. *The Wisconsin Card-Sorting Test (WCST)* assesses frontal lobe functioning, cognitive shifting, hypothesis testing and problem solving for individuals ages 6 through 90 (Baron, 2004; Golden & Hines, 2011; Somsen, 2007). The *WCST* is one of the most commonly used neuropsychological assessments and numerous studies have been conducted with varying demographic samples to depict its ability to differentiate between frontal lobe dysfunction and its sensitivity to developmental changes (Baron, 2004; Bujoreanu & Willis, 2008; Robinson, Heaton, Lehman & Stilson, 1980; Romine et al., 2004). The test consists of four stimulus cards and two sets of response cards that depict four forms (circles, crosses, triangles, and stars, and four colors) (Golden & Hines, 2007). For the present study, a computerized and paper version of the *WCST* was utilized that requires

participants to determine the correct sorting principle based on feedback of whether their previous answer was correct or incorrect. After a designated amount of time the sorting principle is changed and the participant must adjust his or her sorting strategy accordingly. The number of categories achieved (*WCST* Categories Completed) will be used as a measure of problem solving. Studies exploring the *WCST*'s factor structure identified a three-factor structure, where factor two represents an ineffective hypothesis-testing strategy, which is analogous to the *WCST* Categories Completed (Baron, 2004; Greve, Brooks, Crouch, Williams, & Rice, 1997). Currently there are no studies that have its explored its reliability and validity for this population.

Additionally, the *Rey-Osterrieth Complex Figure Test (ROCFT)* is a constructional copying assessment that measures visual organizational skills and general planning abilities (Baron, 2004; Bernstein & Waber, 1996; Rey, 1941). This assessment required participants to copy a detailed rectangular design with unlimited time and the ability to self-correct mistakes. The *ROCFT* was developed and standardized on a sample of children ages 5-14 and has excellent inter-rater reliability (0.91-0.96), and discriminant validity (Bernstein & Waber, 1996).

Set Shifting/Cognitive Flexibility. The *Trail Making Test* (*TMT*) is a widely utilized measure of neuropsychological functioning due to its sensitivity to brain dysfunction (Baron, 2004; Reitan, 1971; Rosin & Levitt, 1989). It is a timed test that is divided into two parts. Part A requires the individual to draw a line in sequence between numbered circles that are scattered throughout the page, where Part B requires the individual to draw a line to numbered and lettered circles in sequence while alternating between the two (e.g. 1-A-2-B) (Baron, 2004). It has been utilized

with diverse populations (Baron, 2004), however reliability and validity of the test with children has not been fully explored. Part B served as a measure of set shifting/cognitive flexibility, in addition to the *WCST* Perseverative Errors score.

Fluency. The *Controlled Oral Word Association Test* assesses semantic and phonemic fluency that is associated with left cerebral (language) and frontal lobe functioning (Baron, 2004; Rodríguez-Aranda & Martinussen, 2006). Participants are asked to produce words orally to a matching letter (F, A, S) and a semantic category (animals), and are timed for one minute to assess the number of words they can generate. Functional MRI results conducted with children suggest that verbal fluency tests activate the left inferior frontal cortex and dorsolateral prefrontal cortex, and thus are associated with executive functioning abilities (Gaillard et al., 2000). The FAS Test is part of the Neurosensory Center Comprehension Examination for Aphasia (Spreen & Benton, 1977), and the semantic fluency aspect (e.g., animals) is believed to develop more quickly compared to letter fluency because letter fluency requires more mature spelling abilities (Baron, 2004). For example, Tombaugh, Kozak, and Rees (1999) reported that education explained 18.6% of the variance for the FAS trial compared to age (11% of the variance), whereas age explained a greater proportion of variance (23.4%) for the Animals trial compared to educational experience (13.6%) for individuals ages 16-85 years.

Working Memory/Simple Attention. The Story Memory subtest from the *Wide Range Assessment of Memory and Learning (WRAML)* was utilized to serve as a proxy for verbal memory (Sheslow & Adams, 2003). The participant was read two short stories and was asked to recall as many aspects of the story as could be remembered.

After a delayed interval (approximately 15 minutes) the participant was asked to recall the passage. A Story Memory Retention Score was utilized, which accounts for the difference in the Total Score from the initial recall and delayed recall subtests. This subtest has been shown to have excellent reliability (0.93-0.94), and overall high test-retest reliability and content validity (Sheslow & Adams, 2003).

The Connors' Continuous Performance Test-II (CPT-II) is a computerized test of attention and response inhibition for individuals ages 6 through 55+ (Strauss, Sherman, & Spreen, 2006). Continuous performance tests are among one of the most widely used tests of attention and have been used in multiple studies with children and adults (Egeland & Kovalik-Gran, 2010). Participants were asked to press the space bar on a computer keyboard every time a letter appeared on the screen, except for the letter 'X'. The proposed study utilized *t*-scores for Vigilance Hit Reaction Time Block Change (Hit RT Block Change) and Hit Standard Error Block Change (Hit SE Block Change). The Hit RT Block Change measures change in reaction time across duration of the test, while Hit SE Block Change detects changes in response consistency over the duration of the test.

Response Inhibition/Interference Control. The *Stroop-Color-Word Test (SCWT)* is a brief measure that assesses one's ability to shift from one perceptual set to another as requirements change, and the ability to resist distraction (Baron, 2004). The *SCWT* consists of three separate 45 second timed trials of 100-item pages, where the child is first asked to read the names of colors typed in black color, followed by color naming of "XXXX" represented by a specific color (blue, green, and red), and finally a color naming when the words are printed in a non-matched color ink (i.e. Color-

Word trial) (Baron, 2004). For example, in this last trial the word BLUE might be represented in green font, where the child needs to inhibit reading the word BLUE, and name the color of the font. The SCWT has adequate reliability and validity (MacLeod, 1991) and has been shown to be a reliable measure of inhibition (Cox et al., 1997). Children who had difficulty reading the text were not administered the *SCWT* or testing was discontinued. The age corrected Color Word score was utilized as a proxy for Inhibition in the current study. The Wisconsin Card Sorting Task failure to maintain set (*WCST* FMS) was used to measure cognitive interference control. Additionally the *CPT-II* commission score served as a proxy for response inhibition.

Child Maltreatment. Child Maltreatment was defined according to the 1974 Child Abuse Prevention and Treatment Act which defines maltreatment as "any recent act of failure to act on the part of a parent or caretaker which results in death, serious physical or emotional harm, sexual abuse or exploitation, or an act or failure to act which presents an imminent risk of serious harm" (U.S. DHHS, 2011, p.vii). Maltreatment was further divided into four types, including neglect, emotional abuse, physical abuse, and sexual abuse. Within the present study, a conservative approach to entering maltreatment was taken and was only included if it were explicitly written in the intake summary. However, emotional/verbal abuse was difficult to ascertain and clinical judgment, as well as past research findings, was utilized in the decision-making process for inclusion. For example, Higgins and McCabe (2001) have found a high degree of overlap between physical and emotional abuse. Thus, examining the likelihood of these co-occurring types of maltreatment is important.

Physical abuse was defined as the "intentional use of physical force against a child that results in, or has the potential to result in, physical injury" (Leeb, Paulozzi, Melanson, Simon & Arias, 2008, p.14). Sexual abuse was defined as "any completed or attempted (non-completed) sexual act, sexual contact with, or exploitation (i.e., non contact sexual interaction) of a child" (Leeb et al., 2008, p. 14). Emotional abuse is consistently referred to as psychological abuse within the literature and was defined as "intentional caregiver behavior (i.e., act of commission) that convey to a child that he/she is worthless, flawed, unloved, unwanted, endangered, or valued only in meeting another's need (Leeb et al., 2008, p. 16)." Neglect was defined as, "the failure by a caregiver to meet a child's basic physical emotional, medical/dental, or education needs-or a combination thereof" (Leeb et al., 2008, p.17). Based on recommendations from Boxer and Terranova (2008) and Lau et al., (2005), each participants' primary form of child maltreatment was entered based on the hierarchical model of childhood maltreatment. Children who experienced neglect was coded as one, sexual abuse was coded as two, and physical abuse was coded as three. Additionally, many children had experienced multiple forms of childhood maltreatment and this information was entered to align with the cumulative risk model of child maltreatment. Children who were exposed to one type was coded as one, two types was coded as two, three types was coded as three whereas individuals who experienced all four types was assigned a four.

Time of Occurrence. The time within each child's life that maltreatment began was collected (n = 71). This information was no consistently reported.

History of Department of Child and Family (DCYF) Services. Any history of DCYF services was collected.

Post Traumatic Stress Disorder (PTSD). Post Traumatic Stress Disorder diagnosis was based on *The Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM–4*; American Psychiatric Association, 2000) criteria. Children who had a prior diagnosis of PTSD before entering the hospital and/or upon discharge were included within the PTSD group. No children within the outpatient sample had a PTSD diagnosis. The DSM-*4* was used for diagnosis of PTSD in the years 2010-2014.

IQ. *The Wechsler Abbreviated Scales of Intelligence-Second Edition (WASI-II)* and *the Wechsler Intelligence Scale for Children- Fourth Edition (WISC-IV)* were used to measure intelligence for the present study (Wechsler, 2011). The *WASI-II* contains four subtests (Block Design, Vocabulary, Matrix Reasoning, and Similarities) that compose the Full Scale IQ (FSIQ) and has been shown to have excellent test-retest reliability (0.91-0.93), internal consistency (0.96), and concurrent validity with the *WISC-IV and Wechsler Adult Intelligence Scale-Fourth edition* (Wechsler, 2011). The *WISC-IV* was used to measure FSIQ for the outpatient control group. The *WISC-IV* has excellent test-retest reliability (0.93), internal consistency (0.97) and validity (Williams, Weiss & Rolfhus, 2003). One individual was assessed using the Wechsler Preschool and Primary Scale of Intelligence-II, which is a measure of cognitive development for children ages 2-7 years old. The FSIQ served as a control variable within the regression analyses due to previous research suggesting executive functioning and IQ to be significantly related (Arffa, 2007).

CHAPTER 4

RESULTS

Data Analysis Overview

After the data entry and coding process was complete, the Microsoft Excel spreadsheet was uploaded into the statistical analysis program SPSS (21.10 for Mac). All scores were transformed to z scores, and appropriate items were reverse coded. For example, the *Connor's Performance Test* Hit Reaction Time by Block (Hit RT Block Change) score was reversed so that negative Z scores reflected substantial slowing in reaction times. Each variable was checked for its frequency and range of variables. Any variables that were entered incorrectly were removed from the analyses.

Descriptive statistics (means, standard deviations) were calculated for all measures. Correlational analyses were conducted to ensure that the executive functions are not collinear and represent separate constructs. Group differences were explored to learn if groups differed based on age, ethnicity, sex, socioeconomic status, time of maltreatment, DCYF involvement, and special education status. MANOVAs and ANOVAs were conducted to learn if group differences existed between the outpatient and inpatient groups on measures of executive functioning. Then MANOVAs and ANOVAs were conducted to learn if differences existed for individuals using the hierarchical and cumulative models of maltreatment respectively. Discriminant function analyses were then conducted with the combined entire sample to learn if executive functioning would be able to differentiate the types of maltreatment using the hierarchical and cumulative models. After primary hypotheses

were explored, to further understand the role of IQ for the executive functioning of children with a history of maltreatment, a hierarchical multiple regression analysis was employed where FSIQ was entered in stage one, age in stage two, and childhood maltreatment (cumulative and hierarchical independently) were entered in stage three.

Assumption of normality. Analysis of normality for each variable was conducted. Results from analyses of normality revealed *Trail-Making-Test Part B* and *Wisconsin Cart Sorting Test Total Sets* and *Perseverative Error* scores were skewed (|>1.0|). Furthermore, the *Trail-Making-Part B*, *Stroop Color/Word*, and *Wisconsin Card Sorting Perseverative Error* scores were leptokurtic. Figure 2 shows the sample histograms for the *Trail-Making-Test Part B, Stroop Color/Word, and Wisconsin Card Sorting Test Total Sets and Perseverative Error* scores. The assumption of normality was not met for the individual executive functioning scores, except *Verbal Fluency FAS*, when examined for the entire sample (Kolmogorov-Smirnov=.00). Micceri (1989) asserts that amongst educational and psychological research, asymmetry and lumpiness of the data is more the rule than the exception. Furthermore, non-normality was anticipated because participants included within this sample represent a small subset of the population and results are generalizable to only inpatient and outpatient settings.

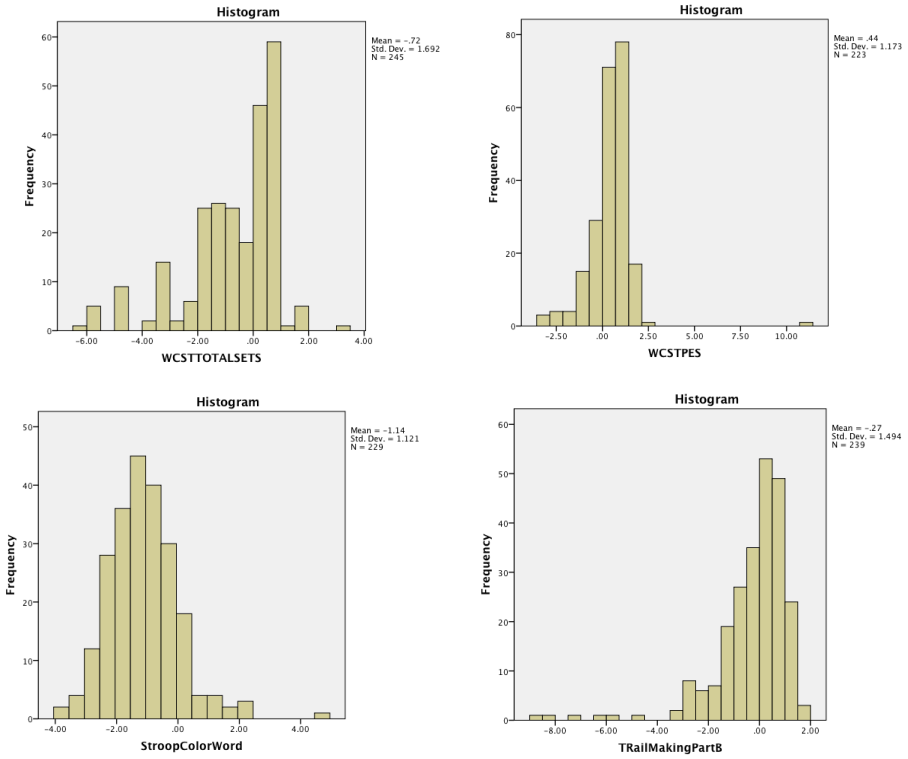

Figure 2. Sample Frequency of Distribution for Executive Functioning Scores

Normality of each executive functioning variable was then analyzed for the inpatient and outpatient group separately. The *Stroop Color/Word, CPT Commission*, *Wisconsin Card Sorting Perseverative Errors* and *Failure to Maintain Set* scores were slightly skewed for the inpatient group. Alternatively, the *Trail-making Part B* and *Wisconsin Card Sorting Perseverative Errors* were asymmetrical for the outpatient sample. In order to learn more about the normality of the distribution, composite executive functioning scores were further examined.

Composite scores were calculated using SPSS for Overall Executive Functioning, Planning/Problem-Solving, Set Shifting/Cognitive Flexibility, Fluency, Working Memory/Simple Attention, and Response Inhibition/Interference Control based on Kavanaugh et al.'s (2014) study. Results from the analysis of normality for

the executive functioning composite scores with the entire sample revealed that these variables were normally distributed, except for the variables Planning/Problem-Solving (-1.27), and Set-Shifting/Cognitive Flexibility (-1.44) being slightly negatively skewed. Based on Fidell and Tabachnick's (2012) recommendations, outliers were further screened. For the Planning/Problem-Solving composite score, five outliers were removed because only one test of planning/problem solving comprised the score. Based on Pallant's (2007) recommendations, removing all composite scores based on the exclusion of one or more variable would drastically reduce the sample size for analyses. However, outliers were not removed if they had all the variables included to represent the composite score. For the Set-Shifting/Cognitive Flexibility composite score, five scores were removed for not having both *Trail Making Part-B* and *WCST-Perseverative Errors* scores. Additionally, one person's score was removed from the outpatient sample due to the participant's *WCST-Perseverative Error* score. The removal of these outliers resulted in the Planning/Problem Solving and Set Shifting/composite scores meeting requirements for normality based on Harlow's (2005) recommendations.

Scatterplots were then examined and all variables met assumptions of linearity for the combined sample. Kolmogorov-Smirnov's test of normality revealed that the combined inpatient and outpatient data met the assumptions of normality for all composite scores except Planning/Problem-Solving, Set Shifting/Cognitive Flexibility, and Response Inhibition/ Interference Control. Further analysis of normality using the Kolmogorov-Smirnov test of normality was used for both the inpatient and outpatient samples independently. The analyses revealed that all of the inpatient executive

functioning composite scores met requirements of normality, however the outpatient Planning/Problem-Solving and Response Inhibition/Interference Control did not meet the requirements for Kolmogorov-Smirnov's test of normality. Furthermore, amongst the outpatient group, approximately 85% were diagnosed with Attention Deficit Hyperactivity Disorder (ADHD), which is a neurodevelopmental disorder commonly associated with deficits in executive functioning. These results suggest that the outpatient sample has a much higher prevalence of neurocognitive deficits compared to the general population, whereas the inpatient group may have a wider variety of neurocognitive and psychological conditions impacting their executive functioning.

Descriptive Information for Each Group

Means and standard deviations were calculated for the inpatient (children with a history of maltreatment) and outpatient samples' measures of executive functioning and are provided in Table 8. As expected, the outpatient group scored higher on measures of IQ, Overall Executive Functioning, Planning/Problem-Solving, Set Shifting/Cognitive Flexibility, Fluency, and Working Memory compared to the inpatient-maltreated group. However, the outpatient group performed lower on measures of Response Inhibition/Interference Control.

Table 8

Summary of Descriptive Results for Each Group

	Outpatient Sample			Child Maltreatment Sample		
	M	N	(*SD*)	*M*	N	(*SD*)
FSIQ (Standard Score)	98.12*	164	12.92	91.24*	108	12.84
Planning/Problem-Solving	-0.29*	165	0.94	-1.20*	92	1.11
Set Shifting/ Cognitive Flexibility	0.28*	147	0.65	-0.07*	96	0.91
Fluency	-0.15*	165	0.96	-0.58*	97	1.00
Working Memory/Simple Attention	-0.10*	163	0.84	-0.67*	95	1.04
Response Inhibition/Interference Control	-0.20*	163	0.21	-0.04*	98	0.25

Note: FSIQ was measured in standardized scores (*M*=100; *SD*=15); Executive Functioning Scores were transformed to z-scores (*M*=0, *SD*=1). * Indicates significant at .05 level.

Child Maltreatment Group. Results of the descriptive statistics revealed that children exposed to some form of maltreatment had a slightly lower mean Overall Executive Functioning score (*M* = -0.40*, SD* = 0.41*)* compared to the outpatient group (*M* = -0.20, *SD* =0.42). In order to learn more about the types of child maltreatment and their impact on executive functioning skills, descriptive statistics were analyzed based on child maltreatment type (e.g., sexual abuse, neglect, emotional abuse, physical abuse). Using a hierarchical model of maltreatment, approximately 38% of children had been neglected (n=42), 33% had been physically abused (n=37), 26% were sexually abused (n=29), and 3% had been exposed to emotional/verbal abuse (n=3). Due to the small sample size of the group that had been exposed to primarily emotional/verbal abuse (n=3), this group was removed from further analyses. The removal of the emotional/verbal abuse group was also done in the Boxer and

Terranova (2008) and Manly et al. (1994) studies due to small sample sizes. Figure 3 depicts the means for each composite measure of executive functioning based on the primary type of childhood maltreatment.

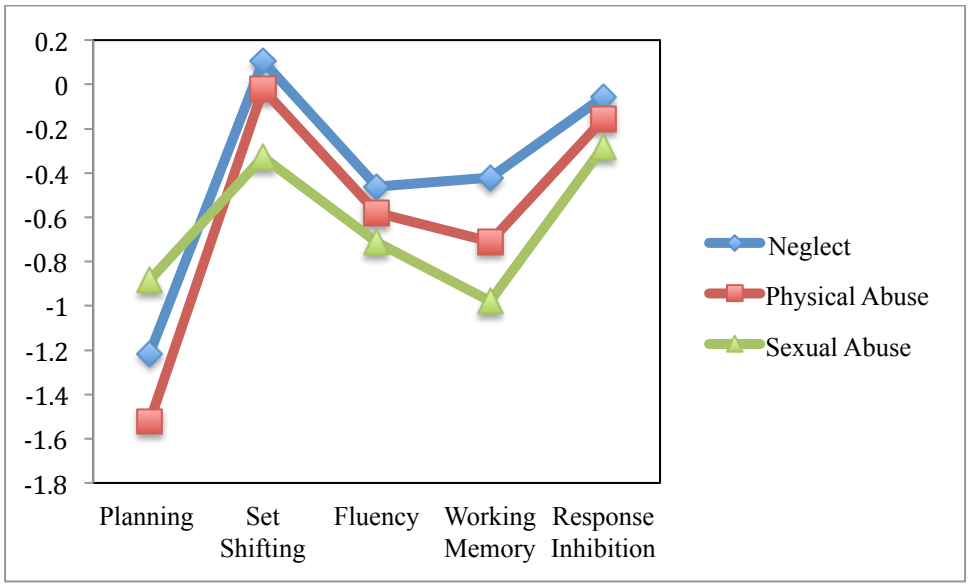

Figure 3. Executive Functioning Outcomes using a Hierarchical Model of Child Maltreatment

Executive Functioning skills were further examined using a cumulative model. Each type of maltreatment the child was exposed to was tallied, with one representing one type of child maltreatment exposure, while four represented that the child was exposed to all four types of maltreatment. Approximately 50% of participants were exposed to one form of maltreatment (n=54), 17% were exposed to two forms of maltreatment (n=19), 20% were exposed to three forms (n=23), and 14% were exposed to all four types of maltreatment (n=15). Figure 4 provides an overview of the impact of cumulative effects of childhood maltreatment on executive functioning.

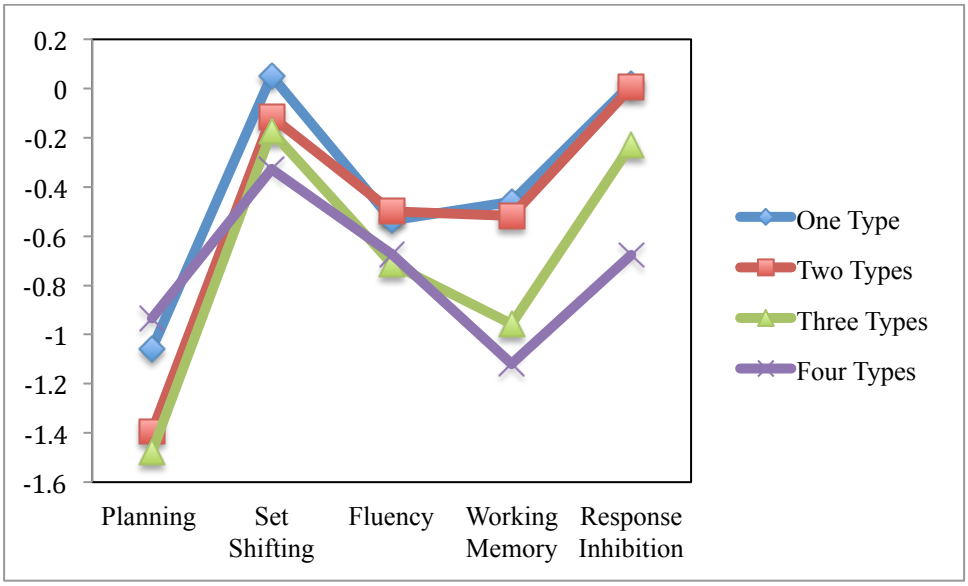

Figure 4. Executive Functioning Outcomes using a Cumulative Model of Child Maltreatment

Post Traumatic Stress Disorder. Children who had a diagnosis of PTSD prior to hospitalization or after discharge from the inpatient psychiatric unit were included within the PTSD group. Approximately 32% of the inpatient population had a diagnosis of PTSD (n=35). Children with PTSD had lower scores of Overall General Executive Functioning skills (M = -0.65, SD = 0.57) compared to those with a history of maltreatment without PTSD (M = -0.52, SD =0.57), and the outpatient group (M = -0.41, SD= 0.53). Figure 5 provides an overview of each specific domain of executive functioning and their association between children with a PTSD diagnosis compared to those with a history of childhood maltreatment without PTSD, and the control group.

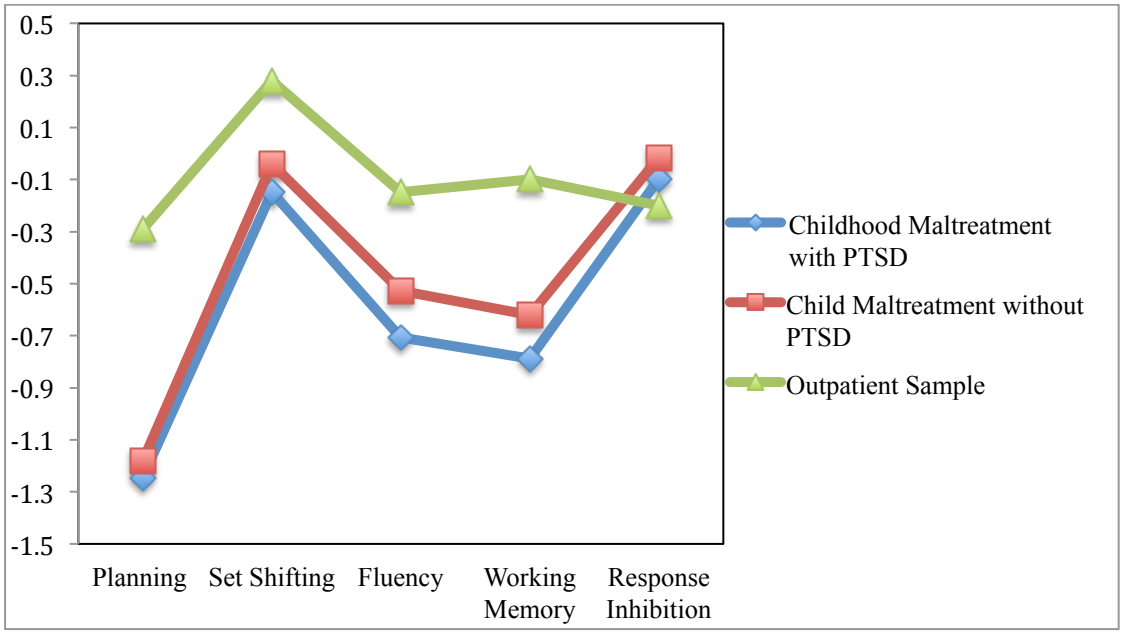

Figure 5. Summary of Descriptive Results for Each Group Based on PTSD diagnosis

Correlational Analysis of Executive Function Composite Scores and FSIQ

Pearson product-moment correlation coefficients were calculated to examine the relationship between the component scores of executive functioning. Results of the correlational analyses are presented in Table 9, and revealed that Planning/Problem-Solving, Fluency, Working Memory/Simple Attention, and Response Inhibition were only slightly correlated with another ($r < 0.20$). Based on Cohen's (1988) guidelines, Set Shifting/Cognitive Flexibility was moderately correlated with Planning/Problem Solving ($r = .42$). These results suggest that the executive functioning composite scores represent fairly independent constructs related to overall executive functioning. FSIQ was also analyzed (see Table 9), and revealed moderate correlations with Planning/ Problem-Solving, Set-Shifting/Cognitive Flexibility, and Fluency (see Table 10).

Table 9

Correlations between Executive Function Composite Scores and FSIQ

	Planning	Set Shifting	Fluency	Working Memory	Response Inhibition	FSIQ
Planning	-	.424**	.178*	.159*	-.071	.451**
Set Shifting	-	-	.235**	.070	.042	.404**
Fluency	-	-	-	.094	-.011	.430**
Working Memory	-	-	-	-	-.067	.243**
Response Inhibition	-	-	-	-	-	.079

Note, * $p < .05$; ** $p<.001$

Between-Group Differences in Executive Functioning

Demographic Differences. To examine demographic differences, between group analyses were conducted with the entire sample (combined inpatient and outpatient group) and then for the inpatient population respectively. An independent-samples *t*-test was conducted to compare Overall Executive Functioning, composite executive functioning scores, and FSIQ for males and females. There were no significant differences ($p >.05$) found for females and males on all measures of executive functioning and FSIQ within the entire combined sample (e.g,. inpatient and outpatient). Additionally there were no sex differences found ($p >.05$) between males and females on measures of executive functioning and FSIQ for maltreated children within a psychiatric inpatient setting.

A one-way between-groups analysis of variance was then conducted to explore the impact of race/ethnicity on executive functioning for the remaining variables. The entire sample consisted of approximately 68% Caucasian, 8% Hispanic, 7% African

American, 5% bi-racial, and 4% of Asian children. Homogeneity of variance was tested using Levene's test. Results from Levene's test of homogeneity of variance revealed violations of this assumption for the variables Planning/Problem-Solving and Working Memory/Simple Attention. Results showed that there was a significant difference on Response Inhibition/Interference Control and Working Memory/Simple Attention for individuals based on their race. Post hoc Games Howell tests were used to control for uneven sample sizes, and did not identify any specific group differences ($p > .05$) based on race. For the variables that did not meet the required assumptions, non-parametric techniques were used to analyze group differences for racial categories and Planning/Problem-Solving and Working Memory/Simple Attention. A Kruskal-Wallis Test revealed a statistically significant difference in Planning/Problem-Solving levels across five races, $\chi^2 = (3, 236) = 14.86$, $p = .005$. A pairwise analysis revealed a significant difference between Caucasian and bi-Racial children on measures of Planning/Problem-Solving ($p_{Adjusted} = .004$), however caution is warranted in this interpretation due to the uneven sample sizes.

Age was also considered as a covariate in this analysis. A one-way between groups analysis revealed no differences on measures of Overall Executive Functioning, and composite scores of executive function based on their age in years, except on the Fluency composite score Fluency for the entire combined sample. There was a statistically significant difference at the $p < .05$ level in Fluency scores for the nine age groups: $F (8, 259) = 3.12$, $p = .002$. The actual difference in mean scores between the groups was small/moderate. The effect size, calculated using eta squared,

was .09. Post hoc comparisons using Games-Howell analysis to control for unequal groups revealed no statistical significance between specific age groups.

Special education status could influence the relationship between maltreatment and executive functioning skills. Within the entire sample, approximately 34% of students received special education services. Within the inpatient setting, approximately half of children who had been exposed to some form of maltreatment received special education services. An ANOVA was performed to learn if group differences existed between individuals who received special education services on Overall Executive Functioning. Results revealed a significant difference between individuals who had an Individualized Education Plan (IEP) and those who did not, $F(1,269)=16.07$, $p=.001$. Children who received special education services performed significantly lower than children who did not have an IEP (p= .001).

In order to further explore group differences in special education status with respect to specific executive functioning skills, a Multivariate Analysis of Variance (MANOVA) was utilized. All assumptions were met based on Box's Test of Equality of Covariance Matrices test; however Set-Shifting/Cognitive Flexibility revealed violations in the equality of error variances. In order to control for this, a more conservative alpha level was used, as recommended by Tabachnik and Fidell (2007). Results from the MANOVA revealed significant difference between individuals that receive special education services and those who do not, $F(1,216) = 6.31$, $p = .001$, *Pillai's Trace* = 0.13. Specifically, children who received special education services performed significantly lower on measures of Planning/Problem-Solving ($p = .001$) and Set-Shifting/Cognitive Flexibility ($p=.001$).

Finally, two variables related to maltreatment were collected, including history of involvement with the Department of Youth and Family (DCYF) Services and the time maltreatment began. The time of maltreatment was defined as the time in the child's life when any form of maltreatment began. This variable was categorized into first year of life, second year of life, third year of life, and so on. History of DCYF was defined as a dichotomous Yes/No variable. Results using group difference statistics (ANOVA) revealed no group differences on executive functioning skills or FSIQ based on history of involvement with DCYF or when maltreatment began.

Inpatient vs. Outpatient Group Differences. Group differences were examined between the outpatient sample and inpatient sample (e.g., child maltreatment group). First an independent t-test was conducted to compare the Overall Executive Functioning scores for the inpatient and outpatient groups. There was a significant difference in scores for the inpatient (M = -0.40, SD = 0.41) and outpatient groups (M = -0.20, SD = -0.42); $t\ (272) = -4.02,\ p = .001$). The magnitude of the difference in the means (mean difference = -0.21, 95% CI: -0.31 to -.10) was small to moderate (eta squared = .09). As anticipated, group differences in Overall Executive Functioning between the inpatient and outpatient groups were found.

A one-way between groups multivariate analysis of variance (MANOVA) was performed to investigate group differences in Planning/Problem-Solving, Fluency, Working Memory/Simple Attention, Response Inhibition, and Set Shifting/Cognitive Flexibility skills between the inpatient and outpatient group. Preliminary assumption testing was conducted to check for normality, linearity, homogeneity of variance-covariance matrices, and multicollinearity, with no serious violations noted. There was

a statistically significant difference between children who experienced child maltreatment and the outpatient group on the combined dependent variable, F (1, 219) = 24.01, p = .001; *Pillai's Trace* = 0.36). Additionally, maltreatment/inpatient status explained approximately 36% of the variance of the scores, representing a large effect size according to Cohen's (1992) recommendations (η^2 =. 360). When the results for the dependent variables were considered separately, each executive functioning skill reached statistical significance (see Table 10).

Table 10

MANOVA Between-Subjects Results of Executive Functioning Between the Outpatient and Child Maltreatment/Inpatient Groups

	df	Mean Square	F	Sig.	η^2
Planning/ Problem-Solving	1 219	44.86	49.89	.001**	.187
Set-Shifting/ Cognitive Flexibility	1 219	5.97	10.46	.001**	.046
Fluency	1 219	4.9	5.26	.023*	.024
Working Memory/ Simple Attention	1 219	14.30	16.57	.001**	.071
Response Inhibition/ Interference Control	1 219	15.97	39.32	.001**	.153

Note, * p < .05; ** p<.001; Cohen's (1992) Recommendations: η^2 = .02 (Small Effect); η^2 =. 13(Medium Effect): η^2 = .26 (Large Effect Size)

Hierarchical Model of Maltreatment. Group differences were analyzed for the entire sample to learn if there were differences between the outpatient sample and

inpatient sample on measures of Overall Executive Functioning, Planning/Problem-Solving, Fluency, Working Memory/Simple Attention, Response Inhibition, and Set Shifting/Cognitive Flexibility using the hierarchical model of maltreatment. The hierarchical model was defined using a single type of maltreatment based on previous research (Boxer & Terranova, 2008; Lau et al., 2005), where sexual abuse is seen as more detrimental (see Figure 6). Results from the one-way between groups analysis of variance revealed a significant difference between groups on a measure of Overall Executive Functioning based on a hierarchical model, $F(3, 270) = 6.91$, $p = .001$. Post hoc analysis using Games-Howell tests to control for unequal group sizes revealed a significant difference between those who experienced sexual abuse ($p = .006$) and physical abuse ($p = .008$) compared to the outpatient group. There was no significant difference between the outpatient group and children who had been neglected on Overall Executive Functioning ($p = .297$).

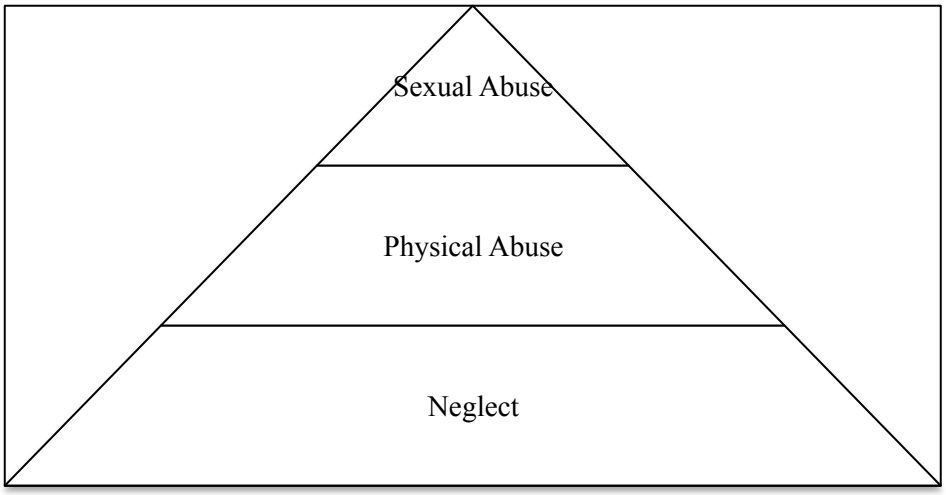

Figure 6. Hierarchical Model of Maltreatment

A one-way between-groups analysis of covariance (ANCOVA) was conducted to compare the type of maltreatment using a hierarchical model on Overall Executive Functioning after controlling for FSIQ. Preliminary checks were conducted to ensure

there were no violations in linearity, homogeneity of variance, and homogeneity of the regression slopes. After adjusting for FSIQ, there was a significant difference between the type of maltreatment the child was exposed to and Overall Executive Functioning, $F(3, 268) = 3.39$, $p = .02$. FSIQ explained approximately 28% of the variance of Overall Executive Functioning, while the primary form of maltreatment explained an additional 4% of the variance. Pairwise comparisons with Bonferroni corrections revealed significant differences between individuals who had no history of maltreatment and those who had experienced physical abuse ($p = .02$) after controlling for FSIQ.

In order to learn if the inpatient and outpatient groups differed on executive function measures based on a hierarchical child maltreatment model, a MANOVA was conducted. Tabachnik and Fidell (2007)'s recommend using a chi-square table with a critical value of 20.52 for five dependent variables to compare to the sample's Mahalanobis distance. Mahalanobis distance maximum value was calculated to be 23.88, indicating that any scores greater than this number were considered extreme scores. In this sample only two scores were calculated above the critical value and were retained in the present analysis based on Pallant's (2007) recommendations. Levene's statistic revealed that Set-Shifting/Cognitive Flexibility and Working Memory/Simple Attention violated assumptions of homogeneity of variance.

More robust tests of equality of the means are considered when the assumption of homogeneity of variance has not been met. The Welch and Brown-Forsythe test revealed that there were significant group differences. Due to the unequal sample size amongst groups, heterogeneity of variance was to be expected. Tabachnik and Fidell

(2007) suggest using a more conservative alpha level (.025) for determining significance for data that violates this assumption. Results from the MANOVA revealed significant differences between groups based on the combined dependent variable, F (3, 216) = 6.84, p = .001; *Pillai's Trace* = 0.42. p < .001) on all measures of executive functioning based on the hierarchical maltreatment model. The hierarchical model explained approximately 39% ($\eta^2 = 1- \Lambda$**)** of the variance of the combined executive functioning skills.

An ANOVA was then conducted in order to further explore group differences (see Table 11). The Games-Howell post hoc analysis was utilized due to the heteroscedasticity of the data and unequal sample sizes. There was a significant difference between children who did not have a history of maltreatment (M = -0.29, SD = 0.94) and children who have been neglected (M = -1.21, SD = 1.06, p =.001) and physically abused (M = -1.52, SD = 1.06, p = .001) on the Planning/Problem-Solving composite score. Within the Set Shifting/Cognitive Flexibility scores, group differences were found between the outpatient sample (M = 0.28, SD = 0.65) and children who had been sexually abused (M = -0.33, SD = 0.85, p = .002). Similarly, children who were sexually abused (M = -0.98, SD = 0.92) performed significantly lower on measures of Working Memory/Simple Attention compared to those with no history of maltreatment (M = -0.10, SD = 0.84, p = .001). For Response Inhibition/Interference the Control, Games-Howell test revealed the outpatient sample (M = -0.60 SD = 0.63) performed significantly lower than children who had been neglected (M = -.06, SD = 0.71, p = .001), and physically abused (M = -0.16, SD = 0.79, p =.022).

Table 11

ANOVA Results of Executive Functioning based on the Hierarchical Model of Maltreatment

		Sum of Squares	df	Mean Square	F	Sig.
Planning/ Problem-Solving	Between Groups	56.79	3	18.93	19.04	.001**
	Within Groups	248.57	250	.99		
	Total	305.36	253			
Set-Shifting/ Cognitive Flexibility	Between Groups	9.29	3	3.10	5.32	.001**
	Within Groups	137.49	236	.583		
	Total	146.79	239			
Fluency	Between Groups	11.63	3	3.39	4.04	.008*
	Within Groups	244.33	255	.958		
	Total	255.95	258			
Working Memory/ Simple Attention	Between Groups	25.17	3	8.39	10.28	.001**
	Within Groups	204.94	251	.816		
	Total	230.10	254			
Response Inhibition/ Interference Control	Between Groups	13.03	3	4.34	9.670	.001**
	Within Groups	114.12	254	.45		
	Total	127.15	257			

Note, * $p < .05$; ** $p<.001$

A Multivariate Analysis of Covariance (MANCOVA) was used to explore if a hierarchical model of child maltreatment would explain executive function skills after controlling for FSIQ. FSIQ explained approximately 37% of the variance of combined executive functioning skills. After controlling for FSIQ, the primary type of maltreatment continued to explain a significant effect on the combined executive functioning skills, $F(3, 215) = 6.65$, $p = .001$, *Pillai's Trace* = .414, partial eta squared = .14. Tests of Between-Subjects Effects revealed significant differences between

groups on measures of Planning/Problem Solving ($F(3, 215) = 17.61$, $p = .001$, partial eta squared =. 20), Set Shifting/Cognitive Flexibility ($F(3, 215) = 2.80$, $p = .04$, partial eta squared =. 04), Working Memory ($F(3, 215) = 14.82$, $p = .003$, partial eta squared = .06), and Response Inhibition/Interference Control ($F(3, 215) = 13.39$, $p = .001$, partial eta squared =.16). Group differences for Fluency did not meet significance ($p = .197$). Pairwise comparisons using Bonferroni corrections revealed group differences between the outpatient group and individuals who have experienced neglect ($p = .001$) and physical abuse ($p = .001$) on Planning/Problem-Solving. Working Memory was significantly more impaired for individuals who had been sexually abused compared to the outpatient group after controlling for FSIQ ($p = .036$). Finally, after considering FSIQ, group differences existed between the outpatient group and individuals who had been neglected ($p = .001$), sexually abused ($p = .046$), and physical abused ($p = .001$) on measures of Response Inhibition/Interference Control.

Cumulative Model of Maltreatment. An ANOVA was conducted with the combined inpatient and outpatient groups to learn if differences in Overall Executive Functioning exist with respect to a cumulative model of child maltreatment. Cumulative was defined as the number of types of maltreatment the child had been exposed. Individuals were divided into five groups (outpatient/no history of maltreatment, one form of maltreatment, two forms of maltreatment, three forms of maltreatment, and four types of maltreatment). There was a statistically significant difference at the $p < .001$ in Overall Executive Functioning scores for the five groups, $F(4, 274) = 6.64$. Games-Howell post-hoc analyses revealed that individuals without a

history of maltreatment (M = -0.20, SD = 0.42) significantly differed on a measure of Overall Executive Functioning from individuals who had experienced three (M= -0.60, SD = 0.39, p = .001) and four types (M = -0.52, SD = 0.36, *p* = .029) of maltreatment. Additionally individuals who experienced one form of maltreatment (M = -0.29, SD = 0.37) performed significantly better on Overall Executive Functioning compared to those who experienced three types of maltreatment (*p* = .028).

In order to understand if there were differences between groups using a cumulative model of maltreatment on specific executive functioning skills, a MANOVA was conducted. Levene's test revealed Planning/Problem-Solving and Set-Shifting/Cognitive Flexibility violated the assumption of homogeneity of variance. Welch's and Brown-Forsythe's robust test of equality of means revealed adequate levels for analysis, and more conservative alpha levels were used to define significant group differences. Results from the MANOVA revealed that there were significant group differences on the combined executive functioning skills between the inpatient and outpatient groups based on the cumulative effects of maltreatment, *F* (4, 219) = 5.45, *p* = .001, *Pillai's Trace =.454,* partial eta squared = .113). ANOVAs were then conducted to learn about group differences and are presented in Table 12.

Table 12

ANOVA Results of Executive Functioning based on the Cumulative Model of Maltreatment

		Sum of Squares	df	Mean Square	F	Sig.
Planning/ Problem-Solving	Between Groups	53.03	4	13.26	13.18	.001**
	Within Groups	253.45	252	1.01		
	Total	306.47	256			
Set-Shifting/ Cognitive Flexibility	Between Groups	8.96	4	2.24	3.82	.005*
	Within Groups	139.51	238	.586		
	Total	148.47	242			
Fluency	Between Groups	12.34	4	3.09	3.21	.014*
	Within Groups	247.34	257	.962		
	Total	259.68	261			
Working Memory/ Simple Attention	Between Groups	26.79	4	6.70	8.10	.001**
	Within Groups	209.28	253	.827		
	Total	236.07	257			
Response Inhibition/ Interference Control	Between Groups	19.29	4	4.82	10.90	.001**
	Within Groups	113.32	256	.443		
	Total	132.61	260			

Note, * $p < .05$; ** $p<.001$

The Games-Howell post hoc test revealed significant differences between the outpatient group (M = -0.29, SD = 0.94, p = .001), and those who experience one form (M = -1.06, SD = 1.06, p = .001), two forms (M = -1.39, SD = 0.84, p = .001), and three forms (M = -01.48, SD =1.15, p = .001) of child maltreatment on a measure of Planning/Problem-Solving. Group differences on measures of Set-Shifting/Cognitive Flexibility (M = -0.33, SD = 0.58, p = .039) and Working Memory/Simple Attention (M = -1.11, SD = 0.84, p = .004) existed only for the outpatient group and those who experienced neglect, emotional abuse, physical abuse, and sexual abuse (e.g., four

types of maltreatment). The control group (M = -0.15, SD = 0.96, p=.001) and children who experienced three forms of maltreatment differed on a measure of Fluency (M = -0.71, SD = 0.79, p = .040). Lastly, results of the Games-Howell test revealed that children who experienced one form (M = 0.02, SD = 0.69, p = .001) and two forms (M = 0.005, SD = 0.79, p= .035) of maltreatment differed from children who had never been maltreated (M = -.60, SD = 0.63), on a measure of Response Inhibition/Interference Control. The outpatient group performed significantly lower on the Response Inhibition/Interference Control compared to the inpatient group, however individuals who experienced three and four types of maltreatment did not significantly differ from the outpatient population, suggesting impairment in the abilities of resisting distractions and avoiding one's first reaction for individuals who experienced multiple forms of maltreatment. Table 13 provides an overview of the hierarchical and cumulative models of maltreatment and the executive function skills impacted.

Table 13

Significant Group Differences in Executive Functioning Compared to the Outpatient Sample

	Hierarchical Model of Child Maltreatment	Cumulative Model of Child Maltreatment
Planning/ Problem-Solving	Neglect (*p*=.001) Physical Abuse *(p*=.001)	One Type of Maltreatment (*p*=.001) Two Types of Maltreatment (*p*=.001) Three Types of Maltreatment (*p*=.001)
Set-Shifting/ Cognitive Flexibility	Sexual Abuse (*p*=.002)	Four Types of Maltreatment (*p*=.039)
Fluency	None	Three Types of Maltreatment (*p*=.040)
Working Memory/ Simple Attention	Sexual Abuse (*p*=.001)	Four Types of Maltreatment (*p*=.004)
Response Inhibition/ Interference Control	Neglect (*p*=.001) Physical Abuse (*p*=.001)	One Type of Maltreatment (*p*=.001) Two Types of Maltreatment (*p*=.035)

Note, The outpatient group performed significantly lower on measures of Response Inhibition/Interference Control

A one-way between-groups analysis of covariance (ANCOVA) was conducted to compare the impact of maltreatment on Overall Executive Functioning after controlling for FSIQ using a cumulative model. After controlling for FSIQ, there was a significant effect of the cumulative types of maltreatment on Overall Executive Functioning, $F(4, 271) = 3.74$, $p = .01$. After considering FSIQ, the cumulative model of child maltreatment explained approximately five percent of the variance of Overall Executive Functioning. Pairwise comparisons with Bonferroni corrections revealed

significant differences between individuals who had no history of maltreatment and those who had three types of maltreatment (p = .008) after controlling for FSIQ. Additionally, after controlling for FSIQ, group differences were noted between those who experienced one type of maltreatment and three types of maltreatment (p = .03), suggesting that three types of maltreatment may result in reduced skills associated with Overall Executive Functioning.

Lastly, a MANCOVA was performed to learn if the cumulative model of maltreatment would continue to explain independent variance of executive functioning skills. After controlling for FSIQ, the cumulative model of maltreatment explained a significant proportion of combined executive functioning skills, $F(4, 218) = 5.11$, p = .001, *Pillai's Trace* = .359, partial eta squared = 0.11. Tests of Between-Subjects Effects revealed significant differences between groups on measures of Planning/Problem Solving ($F(4, 218) = 12.44$, p = .001, partial eta squared=.19), Working Memory ($F(4, 218) = 4.34$, p=.002, partial eta squared = .08), and Response Inhibition/Interference Control ($F(4, 218) = 13.36$, p = .001, partial eta squared =.20). Group differences for Fluency (p = .45) and Set-Shifting/Cognitive Flexibility (p = .10) did not meet significance.

Pairwise comparisons using Bonferroni corrections revealed group differences after controlling for FSIQ between the outpatient group and individuals who have experienced one form of maltreatment (p = .001), two forms (p = .001), and three forms (p = .001) of maltreatment on Planning/Problem-Solving. Working Memory/Simple Attention was significantly more impaired for individuals who had been exposed to four forms of maltreatment compared to the outpatient group after

controlling for FSIQ (p = .003). Finally, after considering FSIQ, the outpatient group continued to exhibit lower functioning on measures of Response Inhibition/Interference Control compared to the individuals exposed to one type (p = .001), two types (p = .001), and three types of maltreatment (p = .015). Individuals exposed to four types of maltreatment (M = -0.65, SD = 0.89) and the outpatient sample maltreatment (M = -0.60, SD = 0.62) did not differ on the measures of Response Inhibition/Interference Control.

PTSD. The effects of PTSD on a global measure of executive functioning were explored to understand if group differences existed for children exposed to childhood maltreatment with a diagnosis of PTSD, children exposed to maltreatment without PTSD, and those without a history of maltreatment (outpatient group). A one-way between group analysis of variance revealed a significant difference (p = .001) between groups on Overall Executive Functioning. Post hoc analyses using Games-Howell analysis revealed a significant difference between the outpatient sample (M = -0.19, SD = 0.42) and those with a history of maltreatment with a diagnosis of PTSD (M = -0.46, SD = 0.37, p = .002). Group differences were also found between the outpatient group and those with a history of maltreatment without PTSD (M = -0.38, SD = 0.42, p = .008). After controlling for FSIQ, presence of PTSD no longer predicted Overall Executive Functioning skills, F (2, 271) = 2.62, p = .11).

Group differences were then analyzed for each executive functioning skill. There was a minor violation in homogeneity of between-group variance, but Brown–Forsythe F and Welch's F adjustments showed that this had no impact on the observed outcome. The MANOVA revealed significant differences between children who had

been maltreated with PTSD, children who had been maltreated without PTSD, and controls on measures of Planning/Problem-Solving, Set-Shifting/Cognitive Flexibility, Fluency, Working Memory/Simple Attention, and Response Inhibition/Interference Control, $F(2,219) = 9.70$, *Pillai's Trace* = .371, $p = .001$.

To further examine if group differences existed between children with PTSD and those with a history of maltreatment and children with no history of maltreatment, post hoc analyses were conducted. Games-Howell post hoc analyses revealed that children with a history of maltreatment with and without PTSD differed from the outpatient group on measures of Planning/Problem Solving ($p = .001$) and Response Inhibition/Interference Control ($p = .01$). Only children with a PTSD diagnosis differed on Fluency measures ($p = .02$) compared to the outpatient group. No group differences were noted between children who had been maltreated with PTSD and those who were maltreated without a PTSD diagnosis.

A MANCOVA was utilized in order to understand if a diagnosis of PTSD would continue to explain differences in executive functioning after controlling for FSIQ. Results revealed PTSD diagnosis explained unique variance of combined executive functioning scores, $F(2, 218) = 9.36$, $p = .001$, *Pillai's Trace* = .363, partial eta squared = .182. This difference only reached significance for the Planning/Problem-Solving ($p = .001$), Working Memory ($p = .002$), and Response Inhibition/Interference Control ($p = .001$) composite scores.

Hierarchical Model of Child Maltreatment within an Inpatient Setting

A one-way between-groups analysis of variance was conducted to examine differences of Overall Executive Functioning based on the hierarchical model of child

maltreatment, which identified a primary type of maltreatment, within the inpatient sample. Each primary type of child maltreatment was compared to understand if group differences existed on measures of overall executive functioning. There were no significant differences (p = .15) between children who were exposed primarily to neglect, sexual abuse, or physical abuse on a measure of Overall Executive Functioning.

In order to understand group differences in specific aspects of executive functioning using a hierarchical model of childhood maltreatment, initial analyses were conducted in order to meet assumptions needed for multivariate analysis of variance. Analysis using Box's M Test of Equality of Covariance Matrices suggested that the data did not violate homogeneity of variance. Levene's Test of Equality of Error Variances suggested that Working Memory/Simple Attention violated the assumption of equality of variances (>.05). Tabachnik and Fidell (2007) suggest a more conservative alpha level (.025) for defining significance for data that violates this assumption. Results from the multivariate analysis of variance on different executive functioning skills revealed no significant differences on measures of executive functioning based on primary form of maltreatment (e.g., neglect, physical abuse, and sexual abuse), $F(3, 73) = 1.58$, p = .12; Pillai's Trace = .212, partial eta squared = .106. These findings suggest that no differences exist for children's specific executive functioning skills based on the type of maltreatment exposure.

When conducting multivariate analysis using SPSS, the number of participants that are included in the sample are automatically removed listwise, thus reducing the sample size. In order to examine group differences between measures of executive

functioning using a primary maltreatment model, a one-way analysis of variance was conducted. The use of ANOVA in SPSS allows for scores to be deleted on a case-analysis basis, allowing for an increased sample size. Results of the analysis of variance for each executive functioning composite score revealed no group differences ($p > .05$).

Cumulative Model of Child Maltreatment within an Inpatient Setting

Levene's test of homogeneity of variance, and more robust tests of Equality of Means (Welch's and Brown-Forsythe tests) revealed no violations of homogeneity of variance for Overall Executive Functioning while using a cumulative model to measure child maltreatment. An ANOVA was conducted to understand if difference existed in Overall Executive Functioning using a cumulative model of maltreatment. Results revealed a significant difference between groups $F(3, 108) = 2.88$, $p = .04$). Post hoc analyses did not reveal any significant difference between groups ($p > .05$), however group differences between children who experienced one form of maltreatment and four types of maltreatment differed at the $p = .058$ level.

Next, a multivariate analysis of variance was conducted in order to understand group differences in specific executive functioning skills using a cumulative model of childhood maltreatment. Box's M Test of Equality of Covariance Matrices suggested the data met the assumption of homogeneity of variance. Levene's Test of Equality of Error Variances suggested that Set Shifting/Cognitive Flexibility violated the assumption of equality of variances (>.05). Thus a more conservative alpha level (.025) was utilized for this variable. Results from the multivariate analysis of variance on different executive functioning skills revealed no significant differences on

measures of executive functioning based on the cumulative conceptualization of maltreatment, F(3, 73) = 1.25 p = .24, Pillai's Trace = .246, partial eta squared = .082. These findings suggest that no differences exist for children's specific executive functioning skills based on exposure to cumulative effects of maltreatment.

A one-way between-groups analysis of variance was conducted to explore the impact of the cumulative effects of maltreatment on executive functioning skills. As noted previously, the multivariate analysis of variance revealed no significant differences between groups, but reduced the sample size by as much as 25%. Huberty and Morris (1989) suggest that ANOVAs are recommended when they specifically align with the research question, and are commonly used following a MANOVA. Results from the one-way analysis of variance revealed a significant difference at the $p < .05$ level for Working Memory/Simple Attention, F(3, 97) = 3.24, p =.026, and Response Inhibition/Interference Control, F(3, 108) = 2.88, p =.039 . Post-hoc analysis using the Games-Howell test indicated that the mean score for those exposed to one form of child maltreatment was significantly different from those exposed to four types of child maltreatment on a measure of Working Memory/Simple Attention ($M_{difference} = -0.69$). No group differences were significant ($p > .05$) for Response Inhibition/Interference Control.

PTSD within an Inpatient Setting

Analyses were conducted to learn if group differences existed within the inpatient psychiatric hospital population on measures of executive functioning based on the diagnosis of PTSD. First an independent *t*-test was conducted to learn if these groups differed on a measure of Overall Executive Functioning. Results indicated that

children with a PTSD diagnosis (M = -0.50, SD = 0.57) and without a PTSD diagnosis (M = -0.50, SD = 0.55) did not differ on their overall executive functioning abilities. Next, multiple ANOVAs were performed, due to the increased sample size for analysis using SPSS, to understand if group differences existed on specific executive functioning skills. There were no group differences on measures of Planning/Problem-Solving, Set-Shifting/Cognitive Flexibility, Fluency, Working Memory/Simple Attention, Response Inhibition/Interference Control (p >.05) for children who had been maltreated with PTSD and those without PTSD. Furthermore, bivariate correlations did not reveal any significant relationship between executive functioning skills and PTSD diagnosis.

In order to learn if specific types of maltreatment were correlated with PTSD diagnosis, Spearman's rank-order correlations were conducted. Types of maltreatment were recoded (e.g. presence of abuse, no presence) for each type of maltreatment (e.g. physical abuse, neglect, sexual abuse). PTSD diagnoses were moderately correlated with sexual abuse (r = .38, p = .001) and neglect (r = .29, p = .001), but not physical abuse. Additionally the cumulative level of maltreatment was positively correlated with PTSD diagnosis, suggesting more maltreatment is related to increased PTSD symptomology. Moreover, sex differences were explored motivated by findings suggesting women are more likely to develop PTSD compared to males (Merikangas et al., 2010). Results revealed a small to moderate correlation with sex, suggesting increased PTSD symptomology associated with females compared to males (r = .20, p = .03). Although previous research has shown that lower FSIQ is a risk factor for PTSD symptomology (De Bellis et al., 2009), the present study's findings align with

Bucker et al.'s (2012) findings, suggesting only a small relationship between FSIQ and PTSD (r = -.139, p >.05).

Predicting Child Maltreatment

Hierarchical Model of Child Maltreatment. Discriminant Function Analysis (DFA) is commonly used as a follow-up procedure to a significant MANOVA to understand which discriminating variables most strongly differed among the groups (Harlow, 2005). Step-wise DFA was used to understand which of the predictor variables (Planning/Problem-Solving, Set-Shifting/Cognitive Flexibility, Fluency, Working Memory/Simple Attention, and Response Inhibition/Interference Control) best-classified maltreatment status for the entire sample (inpatient and outpatient) based on the hierarchical model of maltreatment. DFA was not conducted for the inpatient-only sample due to the lack of significant MANOVA findings. The discriminant function revealed a significant association between groups for three predictors, accounting for 47% of between group variability, $F(3, 216) = 11.73$, p = .001.

Closer analysis of the structure matrix revealed only three significant predictors, namely Planning/Problem-Solving (.689), Response Inhibition/Interference Control (-.533), and Working Memory/Simple Attention (.367), with Set-Shifting/Cognitive Flexibility and Fluency being poor predictors. The cross-validated classification showed that overall 71.7% were correctly classified. However, it is important to note Planning/Problem-Solving explains the majority of variance, and this model accurately predicts group membership of the outpatient sample (95%) and moderately for individuals who have been physically abused (63%), however it poorly

discriminates between individuals who have been neglected (8%) and sexually abused (5%).

Cumulative Model of Child Maltreatment. Step-wise DFA was used to learn how well each executive functioning skills effectively predicted group membership using a cumulative effects model of maltreatment. The discriminant function revealed a significant association between groups for the predictors Planning/Problem-Solving (.644), Response Inhibition/Interference Control (-.602), and Working Memory/Simple Attention (.343), accounting for 41% of between group variability, $F(3, 217) = 10.17$, $p = .001$. Similar to the hierarchical model of maltreatment, these predictors correctly classified 71.6% of individuals. Planning/Problem-Solving, Response Inhibition/Interference Control, and Working Memory/Simple Attention accurately predicted group membership for 95% of the outpatient group, 36% for individuals experiencing one type of maltreatment, and 26% of individuals who were exposed to three types of maltreatment. These factors were not able to predict group membership for individuals exposed to two and four types of maltreatment.

Defining Child Maltreatment

In order to best understand how definitions of maltreatment and demographic characteristics predict executive functioning skills, a hierarchical multiple regression was conducted comparing the hierarchical and cumulative models of maltreatment. Multiple regression utilizes continuous variables, however it can also be utilized for dichotomous independent variables. Thus, a primary form of maltreatment based on the hierarchical model was dummy coded and entered into the model. Overall

Executive Functioning was significantly correlated with Sexual Abuse (r = -.16, p = .001) and Physical Abuse (r = -.17, p = .002), but not Neglect (r = -.036 p = .227) using a hierarchical model of child maltreatment. Cumulative level of maltreatment (r = .80, p =. 001) was also significantly correlated with Overall Executive Functioning.

The hierarchical model of maltreatment predicted approximately seven percent of the variance of Overall Executive Functioning scores, while cumulative model explained approximately eight percent of the variance. Additionally, approximately 19% of variance on Planning/Problem-Solving, 5% of Fluency scores, 11% of Working Memory/Simple Attention scores, 10% of Response Inhibition/Interference Control score variance, and 6% of the variance on Set-Shifting/Cognitive Flexibility scores were explained by the hierarchical model. The cumulative model of maltreatment explained approximately 12% of the variance on a score of Planning/Problem-Solving, 6% of the variance on measures of Set-Shifting/Cognitive Flexibility, 4% of variance on Fluency scores, 11% of the variance of Working Memory/Simple Attention scores, 10% of the variance on Fluency measures, and 3% on measures of Response Inhibition/Interference Control. Table 14 and 15 depicts the macro-level results for the hierarchical and cumulative models of maltreatment predicting Overall Executive Functioning scores.

Table 14

Macro-Level Analysis of the Hierarchical Model of Maltreatment Predicting Overall Executive Functioning

Model	Sum of Squares	df	Mean Square	R^2	Adjusted R^2	F-Value	Prob >F
Regression	3.522	3	1.174	.072	.062	6.877	.001
Residual	45.412	266	.171				
Total	48.935	269					

Table 15

Macro-Level Analysis of the Cumulative Model of Maltreatment Predicting Overall Executive Functioning Skills

Model	Sum of Squares	df	Mean Square	R^2	Adjusted R^2	F-Value	Prob >F
Regression	4.172	1	4.172	.084	.081	24.94	.001
Residual	45.491	272	.167				
Total	49.663	273					

Hierarchical multiple regression allows assessment of whether a set of variables adds to the prediction of an outcome variable over and above the variables already in the model (Harlow, 2005). In order to learn if demographic and cognitive factors explain a greater proportion of variance of Overall Executive Functioning within a hierarchical model, age, FSIQ, special education status, PTSD diagnosis, and insurance type (e.g. state insurance, private insurance) were entered in different stages into the model. Special Education status, PTSD diagnosis, and insurance type, which served as a proxy for SES, was not a significant predictor of executive functioning scores for the hierarchical model (p >.05).

As seen in Table 16, the full hierarchical model explains approximately 37% of the variance in Overall Executive Functioning and represents a large effect size (R^2=0.368). Note that effect size estimates are based on Cohen's (1992) recommendations of small ($R^2 = 0.02$), medium ($R^2 = 0.13$), and large (R^2 = 0.32). FSIQ was entered in stage one, followed by age in months, and then primary maltreatment type, respectively. FSIQ explained approximately 31% of the variance in executive functioning skills (F(1,267) = 121.15, p = .001), whereas age in months explained an additional 3% of the variance (F(2,267 = 69.50), p<. 001). Primary form

of maltreatment explained an additional 2.4% of the variance after controlling for FSIQ and age ($F(5,267) = 30.56$, $p = .001$).

Table 16

Macro-level Analysis of Each Step in the Model for Overall Executive Functioning using a Hierarchical Model of Maltreatment

Model	R^2	Adjusted R^2	Standard Error of the Estimate	Sig.
1	.314	.311	.35403	.001
2	.344	.339	.34673	.001
3	.368	.356	.34219	.001

Similar to the hierarchical model, the cumulative model of maltreatment explained approximately 37% of the variance in Overall Executive Functioning and represents a large effect size ($R^2 = 0.365$). FSIQ was entered in step one, age in months in step 2, and the number of types of maltreatments experienced in stage 3. Similar to the hierarchical model, insurance type, PTSD, and special education status did not predict additional variance in overall Executive Functioning skills. Results of the model are presented in Table 17. FSIQ predicted the largest proportion of variance of executive functioning skills, whereas the cumulative model of maltreatment explained 2.1% of the variance in executive functioning representing a small effect size.

Table 17

Macro-level Analysis of Each Step in the Model for Overall Executive Functioning using a Cumulative Model of Maltreatment

Model	R^2	Adjusted R^2	Standard Error of the Estimate	Sig.
1	.314	.311	.35403	.001
2	.344	.339	.34672	.001
3	.365	.358	.34177	.001

CHAPTER 5

DISCUSSION

Child maltreatment continues to be a significant public health crisis leading to adverse effects on biological, psychological, and social systems (APA, 2002). Child maltreatment is particularly detrimental because children lack the ability to protect themselves, both physically and emotionally (De Young et al., 2011b). Maltreatment that occurs during infancy through adolescence is particularly concerning because the brain is rapidly developing during this time period, and any type of trauma can alter typical neurodevelopment (Anda et al., 2006). Additionally, the stress associated with maltreatment may alter cognitive development, neurobiological maturation, and emotional/behavioral regulation (Anda et al., 2005; Carrion & Wong, 2012; Watts-English et al., 2006).

Research has only begun to study the deleterious effects of child maltreatment and its impact on neuropsychological functioning amongst children within the past decade. These studies have provided insight into the biological, psychological, emotional, behavioral, and neuropsychological sequelae of trauma using diverse methodology. However, much of the research on child maltreatment has utilized varying definitions of maltreatment, methodology, populations, and settings, making generalizability difficult. In particular, there have only been a handful of studies that have sought to understand the impact of child maltreatment for children within an inpatient psychiatric setting.

Children in a psychiatric inpatient setting with a history of maltreatment have demonstrated higher levels of suicidality, violence, impulsivity, and post-traumatic

stress symptomology compared to those without a history of childhood maltreatment (Grilo et al., 1999; Liptshitz et al., 2000). Currently only one study has sought to understand the impact of maltreatment on executive functioning for adolescents within an inpatient setting (Kavanaugh et al., 2013). The purpose of the present study was to examine the neuropsychological presentation of children with a history of childhood maltreatment within a psychiatric inpatient setting. Specifically, the current study examined the impact of multiple types of maltreatment on executive functioning skills within an inpatient population to learn if differences exist compared to children with no history of maltreatment.

Summary of Findings

The findings of the current study provide evidence that children with a history of maltreatment within an inpatient setting have impaired executive functioning skills. Specifically, maltreated children performed significantly lower on measures of Planning/Problem-Solving, Set-Shifting/Cognitive Flexibility, Fluency, and Working Memory/Simple Attention. The effect of exposure to maltreatment was maintained even after considering FSIQ and age. Alternatively, the outpatient group performed significantly lower on measures of Response Inhibition/Interference Control. After review of the diagnoses following neuropsychological assessment for the outpatient sample, approximately 85% of children were diagnosed with ADHD. Wodka et al. (2007) suggests that impulse control serves as the primary deficit for individuals diagnosed with ADHD, even during tasks that require minimal executive functioning skills. This aligns with poorer scores on tasks requiring inhibition for the outpatient sample within the present study.

Past research studies have used differential ways of defining maltreatment and have failed to include multiple forms of maltreatment, often obfuscating associated outcomes (Lau et al., 2005). In order to better understand the impact of maltreatment, the present study operationalized maltreatment in two distinct ways. The hierarchical definition of maltreatment, where a primary form of maltreatment is defined, explained approximately 7% of the variance in Overall Executive Functioning scores. Additionally, maltreatment predicted general executive functioning skills even after controlling for FSIQ and age. This model was effective at differentiating between the outpatient group and maltreatment group. It is important to note that Planning/Problem-Solving, Response Inhibition/Interference Control, and Working Memory/Simple Attention scores were able to predict group membership accurately for 63% of the physical abuse individuals, whereas these variables did not accurately predict group membership for those who had been sexually abused or neglected. These findings suggest that other environmental factors or neurocognitive abilities may be more impacted for those with a history of neglect or sexual abuse.

The outpatient group performed better on executive functioning tasks compared to children who had been physically and sexual abused, but not for children whose primary maltreatment type was neglect. De Bellis and colleagues (2009) found that children who had been neglected performed significantly lower on measures of IQ, reading, visual attention, visual memory, language, verbal memory, planning, and problem-solving. However the participants in the De Bellis study were from a community sample, whereas Kavanaugh's (2013) research was conducted within an inpatient setting, and revealed similar findings to the present study with no differences

in executive functioning skills for adolescents who had been neglected. Kavanaugh and colleagues (2013) hypothesized that neglect may negatively affect more global areas of development, whereas sexual abuse and physical abuse may produce a heightened stress response resulting in neurocognitive deficits.

The cumulative model of maltreatment, which examines the multiple types of maltreatment that a child may be exposed to, explained approximately 8% of the variance of Overall Executive Functioning skills. Evans, Li, and Sepanski-Whipple (2013) suggest that understanding multiple risk factors, and how they are associated, provides important information about developmental outcomes. This suggests that including the multiple types of maltreatment explains greater variance in executive functioning skills compared to defining maltreatment using only a primary form. Group differences were found between the outpatient sample and children exposed to three and four types of maltreatment. The cumulative model of maltreatment was able to accurately classify outpatient participants, but less able to differentiate between the cumulative effects of child maltreatment for general executive functioning skills. Additionally, children who had been exposed to one form of maltreatment had higher scores of general executive functioning skills compared to those who were exposed to three forms. These findings align with previous research suggesting reduced executive functioning skills for children exposed to trauma due to maltreatment (Beers & De Bellis, 2002; De Bellis et al., 2009; De Bellis et al., 2013; DePrince et al., 2009; Kavanaugh et al., 2013; Nikulina & Widom, 2013, Nolin & Ethier, 2007) and poorer outcomes associated with the cumulative effects of maltreatment (Anda et al., 2005; Boxer & Terranova, 2008; Lau et al., 2005; Pears et al., 2008).

Executive Functioning Skills Using Two Models of Maltreatment

When the individual executive functioning skills that comprised overall executive functioning were evaluated, the hierarchical model of maltreatment explained 39% of the variance of these scores. Alternatively, the cumulative model of maltreatment explained approximately 43% of the variance of combined executive functioning scores. The Planning/Problem-Solving scores were different between the outpatient group and those who had been neglected and physically abused. This difference remained after controlling for FSIQ. The outpatient group did not differ from children who had been sexually abused in their planning and problem-solving abilities. The cumulative model identified differences between the outpatient group and children exposed to one, two, and three forms of maltreatment, but not all four types. This may be because individuals exposed to all four types would include those who had been sexually abused, which the hierarchical model did not find to be significantly related to measures of Planning/Problem-Solving. Nolin and Ethier (2006) similarly found that children who had been neglected and physically abused performed lower than controls on measures of problem-solving, abstraction, and planning. Alternatively, the authors found that children who were neglected without physical abuse demonstrated a greater capacity for problem-solving, abstraction, and planning compared to controls and those who had been both physically abused and neglected. The cumulative model better aligns with Nolin's findings because after further review of the data, approximately 70% of those who were exposed to three types of maltreatment were exposed to physical abuse, neglect and emotional abuse. These findings point to the importance of defining and measuring maltreatment in

numerous ways because each model works complementarily with the other in explaining outcomes associated with maltreatment.

Only children who had experienced sexual abuse performed lower on measures of Working Memory/Simple Attention and Set Shifting/Cognitive Flexibility compared to the outpatient group. However, only group differences existed in Working Memory/Simple Attention abilities after controlling for FSIQ. This is consistent with findings from the cumulative model that found children who had experienced neglect, sexual, physical, and emotional abuse (e.g. four types of maltreatment) performed significantly lower on measures of Working Memory/Simple Attention and Set Shifting/Cognitive Flexibility. De Bellis et al. (2013) similarly found significant impairments in memory for children who had experienced sexual abuse compared to all other forms of maltreatment. Boxer and Terranova (2008) utilized the hierarchical definition of maltreatment and found that individuals who had experienced sexual abuse had higher levels of psychopathology compared to those who experienced other forms of maltreatment. Furthermore, Kira, Lewandowski, Somers, Yoon, and Chiodo (2012) demonstrated that children who were sexually abused performed lower on measures of working memory and perceptual reasoning and hypothesized that this is due to the high emotional impact sexual abuse has on its victims. Despite these findings, Navalta, Polcari, Webster, Boghossian, and Teicher (2006) found that women who had been sexually abused as children did not differ on measures of short-term memory or verbal memory. The authors did find that the duration of maltreatment significantly mediated this relationship. Duration was not consistently reported for the inpatient group and represents a limitation of this study.

Findings for the present study suggests that skills associated with Working Memory/Simple Attention and Set Shifting/Cognitive Flexibility may be resilient to the effects of neglect and physical abuse, but not sexual abuse. This aligns with previous research suggesting that sexual abuse, in particular, is associated with higher levels of PTSD symptomology and negative developmental outcomes (De Bellis, 1997; De Bellis et al., 1999).

Fluency was the only skill that was unrelated to abuse using the hierarchical model of maltreatment. Age was significantly negatively correlated with fluency, suggesting younger children performed lower on measures of verbal fluency. While some studies have found that children who have been maltreated have lower fluency scores compared to a control group (De Bellis et al., 2009; Kirke-Smith et al., 2014), other studies have shown no differences on measures of verbal fluency (Kavanaugh et al., 2013; Nolin & Ethier, 2007). The cumulative model identified differences between the outpatient group and individuals who experienced three types of maltreatment on measures of fluency, but not all four. A longitudinal study conducted to better understand the correlates of memory for children exposed to trauma found no differences in fluency skills (Hitchcock, Nixon, & Weber, 2014). These findings are consistent with the finding that fluency is generally not impacted by childhood maltreatment for individuals within an inpatient setting, except for those who experience three forms of abuse, mainly emotional abuse, neglect, and physical abuse. Additionally, these findings support the importance of a cumulative model, which identified differences between the increased number of maltreatment experiences, whereas the hierarchical model did not detect any differences.

Results for the Response Inhibition/Interference Control revealed that the outpatient group performed significantly lower compared to the inpatient group using the hierarchical model of maltreatment. Specific differences were found between individuals who experienced physical abuse and neglect compared to the outpatient group. These results revealed that individuals who were sexually abused performed similarly on measures of impulse control. However, after controlling for FSIQ, the outpatient group performed significantly lower than those who had been sexually abused, physically abused, or neglected. Conversely, the cumulative model found no differences on measures of Response Inhibition/Interference Control after controlling for FSIQ for individuals who had been exposed to one, two, and three types of trauma. Differences continued to exist for individuals who experienced four types of maltreatment. These findings align with neuropsychological research that suggests extreme traumatic stress allows the amygdala to assign emotional meaning to non-threatening stimuli/events, which then leads to hyper-arousal and reduced response inhibition (Teicher et al., 2003;Wilson et al., 2011). This suggests that children who have experienced a variety of maltreatment types may have dysregulated stress responses, which then leads to deficits in interference control and inhibition.

Executive Functioning Skills within an Inpatient Setting

A primary purpose of the present study was to learn if type of maltreatment would be related to executive functioning skills within an inpatient setting. When the outpatient group was no longer considered, the hierarchical model did not predict any differences between groups of Overall Executive Functioning skills and composite executive scores. However the cumulative model detected differences between groups

on a measure of Overall Executive Functioning, and revealed significant differences between groups on measures of Response Inhibition/Interference Control and Working Memory/Simple Attention. Specifically, differences were found on measures of Working Memory/Simple Attention between individuals who had experienced one and four types of maltreatment, with individuals who experienced four types of maltreatment having greater impairment. Working memory deficits have been identified for children who have experienced high rates of childhood trauma (Bucker et al., 2012; DePrince et al., 2009; Kavanaugh et al., 2013; Kirke-Smith et al., 2014). Additionally, DePrince and colleagues (2009) found that working memory was more significantly impaired for individuals who have experienced familial trauma compared to those without a history of trauma and those who have experienced trauma non-related to their family. The present sample experienced child maltreatment primarily by a family member, further supporting previous research findings.

Post Traumatic Stress Disorder

In order to learn if PTSD diagnosis was related to lower executive functioning scores, children with a history of child maltreatment and a diagnosis of PTSD were compared with individuals with a history of maltreatment and no history of PTSD diagnosis and the control group. Consistent with previous research conducted with adolescents (Lipschitz, Winegar, Hartnick, & Southwick, 1999), approximately 32% of children who had a history of maltreatment within an inpatient psychiatric setting met criteria for PTSD. PTSD symptomology was moderately correlated with sexual abuse and neglect compared to physical abuse, which was only slightly correlated. Sullivan et al. (2006) similarly found sexual abuse, rather than physical abuse was

related to higher rates of PTSD symptomology, however the authors also found that emotional abuse, rather than neglect significantly related to overall posttraumatic stress within an inpatient setting. Due to the small sample size of individuals constituting the emotional abuse group in the current sample, these findings could not be replicated. However, the moderate correlations for the cumulative effects of maltreatment provide insight into the relationship between increased forms of abuse and PTSD symptomology.

Consistent with previous research (Bucker et al., 2012; De Bellis et al., 2009; De Bellis et al., 2013; Kavanaugh et al., 2013), the findings from the present study revealed significant differences between children with maltreatment-related PTSD compared to healthy controls. However after controlling for FSIQ, a PTSD diagnosis no longer predicted overall executive functioning skills. Contrary to expectations, children with PTSD did not perform significantly lower compared to children with a history of child maltreatment without PTSD. These findings align with Carrion et al.'s (2008) research using fMRI, which found that individuals with post-traumatic stress symptomology performed similarly on a measure of executive functioning, but had different brain regions activated during the same tasks. This suggests that while these children may perform similarly on tasks, their brains may compensate for deficits/alterations due to child maltreatment. Future research utilizing neuroimaging techniques may provide further understanding of brain functioning for children who had been maltreated with and without PTSD.

Consistent with the present study, De Bellis et al. (2013) reported that children with PTSD secondary to maltreatment differed from children with a history of

maltreatment without PTSD on a measure fine motor abilities, but not FSIQ, attention, language, memory, academic achievement, or executive functioning skills. Additionally, De Bellis and colleagues (2009) found only differences on a task of visual memory for children who had been neglected with PTSD and those who had been neglected without PTSD. Beers and De Bellis (2002) found differences amongst children with and without maltreatment-related PTSD on specific measures associated with executive functioning skills, however the authors note caution in generalizing their findings due to the lack of a comparison group and the small sample size (*N*=29). Kavanaugh et al (2013) reported that group differences did not remain between inpatient adolescents exposed to maltreatment compared to controls on measures of executive functioning after controlling for PTSD. These findings were not replicated in the present study, with no significant correlations between PTSD and executive functioning skills. These findings suggest that PTSD symptomology and diagnosis may differentially impact adolescents compared to children within an inpatient setting.

Limitations and Future Directions

There were several limitations of the current study specifically related to reliance on retrospective record review. The intake and discharge summaries were completed by the intake clinician and were not consistently completed and differed by clinician. Additionally, within the past four years the intake and discharge formatting and information provided has frequently changed, leading to inconsistent documentation. In order to gain the most accurate information, all medical files were reviewed to ensure information that was reported was accurate. Despite this, information regarding maltreatment status, perpetrator of maltreatment, duration and

severity of maltreatment, household environment, and indicators of socioeconomic status were not consistently reported. Future research should include this information to learn if these variables mediate/moderate related outcomes. A limitation of this study is that children who were maltreated within the inpatient setting were not compared with those in the inpatient setting who were not maltreated. Future studies should compare the inpatient group with maltreatment to those within an inpatient setting who have not experienced child maltreatment to learn if group differences exist.

Insurance type was used as a proxy of socioeconomic status, however more robust indicators of socioeconomic status are needed. Recent research has demonstrated that socioeconomic status is directly related to executive functioning skills, specifically household composition, family income, parental education, and home enrichment opportunities (Mezzacappa, 2004; Sarsour et al., 2011). However, DePrince et al. (2009) found that socioeconomic status predicted unique variance of FSIQ scores, but not executive functioning scores for a sample of maltreated children. Future research should be conducted to learn more about the role of socioeconomic status for those with a history of maltreatment using more diverse indicators of socioeconomic status.

This study used two different ways to define child maltreatment. While using a hierarchical and cumulative model of maltreatment provided insight into its impact on executive functioning skills, other factors may more reliably differentiate between executive functioning skills. It may be helpful to identify children based on the combined types of maltreatment. For example, those who were exposed to neglect and

physical abuse would compose one group, whereas those who had been neglected, physically abused, and sexually abused would serve as another group. This was not done for the present study because each group would require a large number of participants, thus a larger sample size would be needed to effectively differentiate between groups. Additionally, onset, duration, and severity of each type of maltreatment may provide more information about its impact on brain development and executive functioning skills.

Furthermore, individuals within the child inpatient-setting did not all consistently receive neuropsychological examinations. Primary physicians or psychologists refer children to the neuropsychologist for assessment to further understand neurocognitive processes for children. The children included in this study may therefore represent a population with more severe neuropsychological deficits compared to those within the inpatient unit who did not receive a neuropsychological assessment.

The majority of children who previously experienced maltreatment and were in inpatient setting were on medications to stabilize their emotions and behavior. Understanding executive functioning abilities while the child is not taking medication (that may improve or inhibit their abilities) would provide a better understanding of the true effects of child maltreatment. Additionally, children who were assessed did not consistently receive the full neuropsychological battery due to refusal, time constraints, or because the referral question did not require the full battery to be conducted. Future research should be conducted using more comprehensive

assessments of neuropsychological factors that may include measuring fine motor skills, different aspects of visual and verbal memory, and academic achievement.

While research has not convincingly shown a relationship between maltreatment-related PTSD and poorer executive functioning outcomes compared to children with a history of maltreatment without PTSD, research suggests that poor executive functioning skills may serve as a risk factor for developing PTSD prior to trauma (Aupperle et al., 2012; Gilbertson et al., 2006). Aupperle and colleagues (2012) suggest a model of PTSD where subtle deficits of executive skills prior to trauma are related to increased risk for PTSD due to difficulty inhibiting responses, avoidance, and disengaging from trauma. Understanding children's cognitive abilities prior to child maltreatment may provide schools, families, researchers, and medical professionals with the information needed in order to better understand how executive abilities and intellect prior to trauma impacts PTSD symptomology.

Lastly, research has shown that psychological factors may impact executive functioning skills (Boxer & Terranova, 2008). Past findings have shown that individuals who have been maltreated experience higher anxiety and depressive symptomology, as well as increased overall internalizing symptoms, compared to those with no history of maltreatment (Boxer & Terranova, 2008; Kavanaugh et al., 2013). Internalizing symptoms do not predict poor performance alone; rather affective and cognitive components interact in a metacognitive way that impedes performance (Schmader, Forbes, Zhang, & Mendes, 2009). Understanding the role of internalizing and externalizing symptomology may provide a better understanding of how psychological factors may mediate/moderate executive functioning scores, and the

lack of inclusion of these factors represents a limitation of this study. Additionally, the present study did not seek to understand protective factors that may alter executive functioning skills and limits the generalizability of these findings. Furthermore, children may differ in their neurocognitive skills based on the developmental period of maltreatment and if they had received adequate experience-expected developmental opportunities. Longitudinal studies that include the number of times the children had been hospitalized, medication status/history, use of drugs/alcohol, academic supports, number of perpetrators, available support systems, and PTSD symptomology will contribute to the understanding of outcomes for children who had been maltreated and hospitalized.

Conclusions

The current study demonstrated that within a psychiatric inpatient setting, childhood maltreatment is associated with impairment in general executive functioning, and different types of maltreatment are related to deficits in specific executive functioning skills. However, future research needs to be conducted with children within the inpatient setting to ensure that deficits in executive functioning is not due to the inpatient setting. Conceptualizing maltreatment in two distinct ways provided further evidence how a primary form of maltreatment may identify different children compared to a cumulative model of maltreatment. While the cumulative model explained slightly more variance in executive functioning skills, both models were able to significantly predict neurocognitive scores. Furthermore the hierarchical model did not find significant differences within the maltreated inpatient population on measures of executive functioning, whereas the cumulative model captured group

differences on measures of working memory for those who had experienced one and four types of maltreatment. This study supports the use of defining maltreatment multiple ways, and it is recommended that multiple conceptualizations of maltreatment be included in understanding the impact of child trauma because multiple definitions work symbiotically and allow for better understanding of related outcomes.

The findings from the current study suggest that the working memory abilities and cognitive flexibility are largely impacted for children who have been sexually abused and those who have been exposed to four types of maltreatment. Conversely, the ability to plan and problem-solve was significantly impaired for those who experienced neglect, physical abuse, and for individuals who were exposed to one, two, and three types of maltreatment, but not four. Additionally, the cumulative model found differences between children who had been exposed to three types of maltreatment compared to the outpatient group on measures of verbal fluency. Alternatively the outpatient sample, the majority of whom had an ADHD diagnosis, performed lower on measures of response inhibition compared to those who had been neglected and physical abused, but not sexually abused or experienced four types of maltreatment. These findings suggest that sexual abuse, neglect, and physical abuse, as well as increased exposures to multiple forms of maltreatment impacts executive skills differently. These findings have important implications for clinicians, schools, families, and researchers examining the impact of multiple forms of maltreatment. Understanding the implications of child maltreatment on executive skills will allow for clinicians to provide individuals who are at a higher risk to be maltreated and those

with a history of maltreatment with prevention and intervention strategies that target specific executive functioning skills. Additionally, child neuropsychologists who work within the inpatient setting should provide families and schools with explicit strategies and recommendations to improve executive skills.

The results of this study did not support research suggesting that children with PTSD secondary to maltreatment performed lower on measures of executive functioning. While PTSD originally predicted group differences, after controlling for FSIQ, PTSD no longer explained executive functioning skills. These findings support the majority of research that suggests that FSIQ is significantly related to executive functioning skills. Researchers are encouraged to examine the role of FSIQ and other factors that may impact executive functioning skills for children who have been maltreated in order to better inform interventions and strategies to best understand and help those who have been victimized.

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